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A REMARKABLE LIFE HISTORY AND ITS MEANING.[1]

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NAVIGATORS in tropical seas often speak of sailing for days through regions where the water of the ocean, to a depth of many feet, is filled with small transparent animals, which are attached to each other in such a way as to form chains or trains like trains of cars. Although these animals are perfectly transparent and jelly-like in appearance, the fact that their bodies are of sufficient consistency to admit of their being somewhat roughly handled, or even removed from the water, without essentially changing their shape, at once distinguishes them from such animals as jelly-fishes; and a very superficial examination is enough to show that they are quite different from these in organization. They belong to the group Tunicata, animals which have been classed with the Mollusca, although we now know that the resemblances which formerly led naturalists to this idea of their affinity are merely superficial, and without scientific value.

Most of the Tunicata are, in their adult state, attached to heavy bodies which rest upon the bottom of the ocean; stones and shells, for instance. A few, however, are locomotive and are to be met with swimming at the surface; most of the latter belong to the genus *Salpa*, and to these we will at present confine our attention. Although the Salpæ are most often met with in the warmer parts of the ocean, they are by no means confined to the tropics, but have been found south of the most southern point of Australia, and north of Scotland and Norway. They are abundant only after the water has been for some time undisturbed by winds, and as calms are more frequent within the

[1] A paper read before the Kirtland Society of Natural History of Cleveland, Ohio. The cuts are from a paper upon the development of Salpa, in the Bulletin of the Museum of Comparative Zoölogy, and were kindly loaned for this article by Mr. Agassiz.

tropics than in more northerly or southerly latitudes, the former seas are more favorable than the latter to the development of these animals, which multiply with astonishing rapidity when furnished with abundant food. As they feed upon the microscopic

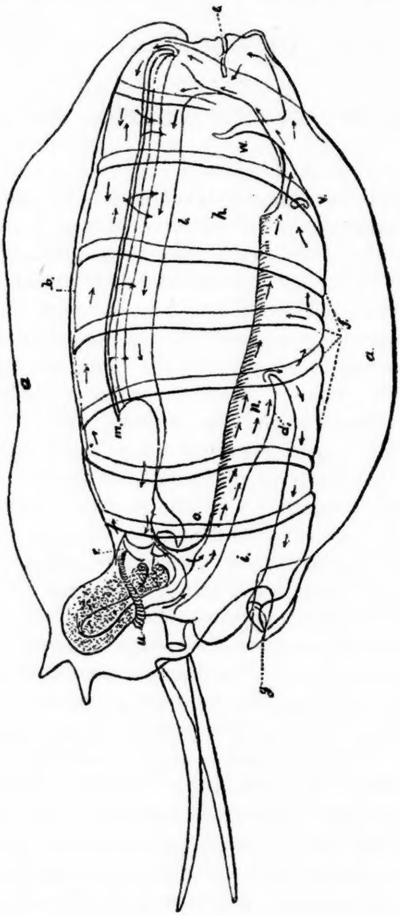


Fig. 43. Side view of an adult solitary Salpa, with the hæmal surface above: *a*, test; *b*, outer tunic; *d*, wall of atrial chamber; *e*, branchial aperture; *f*, muscular girdles; *g*, atrial aperture; *h*, breathing chamber; *i*, atrial chamber; *l*, epipharyngeal fold; *m*, endostyle; *n*, gill; *o*, mouth; *r*, heart; *u*, chain of males; *v*, ganglion; *w*, languette.

rhizopods which swarm at the surface of the ocean after a long-continued calm, they are then met with in numbers which defy description, and cannot be conceived by those who have not actually seen them.

Although single animals of our species are from one half to two thirds of an inch long, they are often so abundant that a bucket of water dipped at random from the surface of some sheltered bay will be found to contain many hundreds or even thousands. At such times collecting with the surface net becomes impracticable; for almost as soon as the net is placed in the water it becomes choked with a solid mass of Salpæ, so that nothing more can enter it, and unless Salpæ are what are wanted work must be abandoned until fresh winds again clear the water. A drop from an organic infusion swarming with Paramecia, seen under a low power of the microscope will give some conception of the appearance of the ocean when Salpæ are abundant, except that the water is not turbid like that of an infusion, but is perfectly fresh and clear; and no one who has not seen these animals under favorable conditions can form any conception of the amount of animal life which pure sea-water is able to support. The various species of Salpa vary in size, from those less than half an inch to those which are nearly a foot long, our species, as already stated, being about two thirds of an inch in length.

The animal (Figures 43 and 44) may be roughly described as a barrel or hollow cylinder, *b*, with a valvular opening at each end. The valves which guard the anterior opening (Figures 43, 45, and 55, *e*) are so arranged that while they allow the water to pass between them into the hollow chamber, *h*, they prevent it from passing out through the same opening; while those at the posterior opening (Figures 43, and 45, *g*) permit it to pass out but prevent its entrance. Around the barrel are a number of muscular belts like the hoops around a barrel (Figures 43, and 44, *f*), the contraction of which diminishes the capacity of the hollow chamber, *h*, and thus drives the water out through the posterior opening in a violent stream, which propels the animal forward. Upon the relaxation of these muscles a new supply of water passes in through the anterior opening, to be expelled in turn by the next contraction. As this pumping action is constantly going on, the animal is continually moving forward in a nearly straight line.

Wherever Salpa is found, two forms are met with, agreeing

pretty closely in size and organization, but differing in outline and in some other slight details. (Compare Figures 43 and 45.) One of these forms, that shown in Figures 43 and 44, is called the "solitary Salpa," since each animal is entirely independent of all the others; while those of the other form (Figure 45) are called "chain-salpæ," since they are usually found united in a chain. Twenty-five or more of the barrel-shaped bodies are placed in a row, end to end, and each one is fastened to its neighbors before and behind it; this row is placed beside another similar to it, and each animal is fastened to two of its neighbors in the other row, so that the whole group of fifty or more forms a chain something like two trains of cars side by side on parallel tracks; only, to make the comparison more perfect, we must imagine each car chained to two cars in the other train, as well as coupled to those before and behind it. Since the animals are fastened in such a way that the posterior openings of all point in the same direction, all the streams of discharged water are driven in the same way and the whole chain moves forward with a uniform, steady motion. Figure 47 shows a few of the Salpæ from a chain, at a very early period of development, but as the animals are, unfortunately, not sufficiently far advanced at this time, the figure fails to give a very clear idea of the way in which they are united.

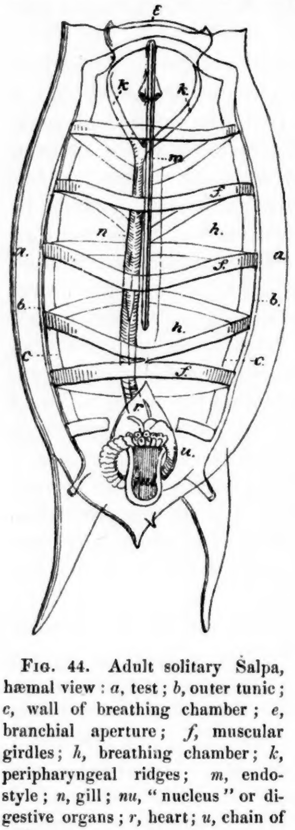


FIG. 44. Adult solitary Salpa, hæmal view : *a*, test; *b*, outer tunic; *c*, wall of breathing chamber; *e*, branchial aperture; *f*, muscular girdles; *h*, breathing chamber; *k*, peripharyngeal ridges; *m*, endostyle; *n*, gill; *nu*, "nucleus" or digestive organs; *r*, heart; *u*, chain of males.

Salpa is very remarkable for the number of examples it presents of deviation from laws which are almost uniformly conformed to throughout the animal kingdom. One of the most striking of these anomalies is the periodical reversal of the action

of the heart. This was discovered in 1824 by Van Hasselt, and although it is not peculiar to Salpa, but is shared by all the Tuni-

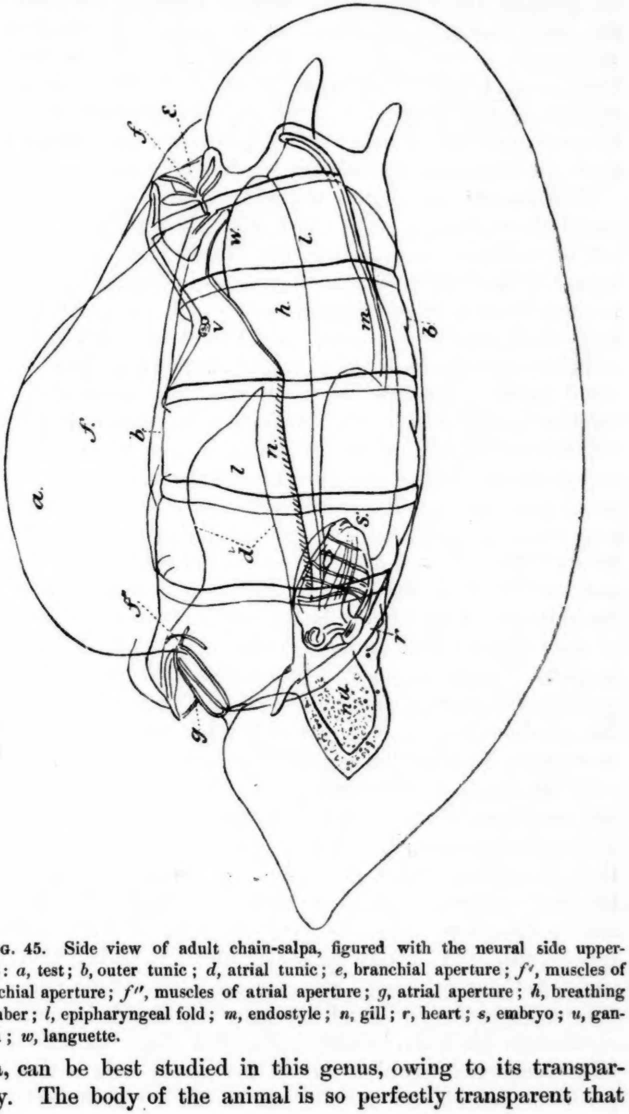


FIG. 45. Side view of adult chain-salpa, figured with the neural side uppermost: *a*, test; *b*, outer tunic; *d*, atrial tunic; *e*, branchial aperture; *f′*, muscles of branchial aperture; *f″*, muscles of atrial aperture; *g*, atrial aperture; *h*, breathing chamber; *l*, epipharyngeal fold; *m*, endostyle; *n*, gill; *r*, heart; *s*, embryo; *u*, ganglion; *w*, languette.

cata, can be best studied in this genus, owing to its transparency. The body of the animal is so perfectly transparent that

the pulsations of the heart may be seen without difficulty, and with a microscope the circulation of the blood may be traced to all parts of the body. After beating regularly for some time the heart suddenly stops, and for an instant the blood of the whole body comes to rest; this stoppage does not last for more than a second, and the pulsation and circulation then recommence as vigorously as before, but in the opposite direction, so that the blood-channels which before served as arteries and carried blood from the heart now perform the function of veins.

More careful examination will show what is possibly the reason of these changes. The blood does not circulate in true vessels with distinct walls, but in the spaces between the various organs of the body; thus it often happens that a space or sinus may have a large passage leading to it on one side and a very small one on the other, and the blood which enters the chamber through the large passage, being unable to escape with equal rapidity through the small one, soon accumulates and forms a dam or obstruction. As soon as the current is reversed, this obstruction is, of course, driven away from the small opening and gradually discharged again through the large one. Another peculiarity which Salpa shares with the other tunicates is the presence of an outer shell or test containing "cellulose." Cellulose is the substance which forms most of the tissues of plants; and although it is almost universally present in vegetables, it is found in only a very few animals, and is often stated to be one of the features which distinguish the vegetable from the animal kingdom. Salpa, however, together with a few other animals, is partially composed of true cellulose. In Figures 43, 44, and 45 the cellulose test, *a*, is shown as a thick transparent shell or outer tube, covering the remaining organs of the body.

By far the most interesting peculiarity of our animals is that the two forms, which are always found in the same locality, are of the same species. Nearly fifty years ago Chamisso ascertained that the solitary Salpa gives birth to a chain, and that each of the chain-salpæ in turn gives birth to a single solitary Salpa; and to this phenomenon he gave the name of "alternation of generations." At about the same time he published his famous story of Peter Schlemihl, who, for an inexhaustible purse, sold his shadow to the devil, and, through lack of this important appendage to his body, became involved in numerous entertaining misfortunes and vexations which his money was powerless to prevent. At this time nothing was known in regard to the won-

derful changes which so many of the invertebrates undergo in passing from the egg to the perfect form ; and the existence of animals whose children resemble their grandparents, while they are quite unlike their parents, was so opposed to all that was known that Chamisso's discovery at first met with nearly universal ridicule and discredit. In fact, one of the greatest of naturalists is stated to have said that he could much more easily credit Chamisso's romance of Peter Schlemihl than his observations upon Salpa.

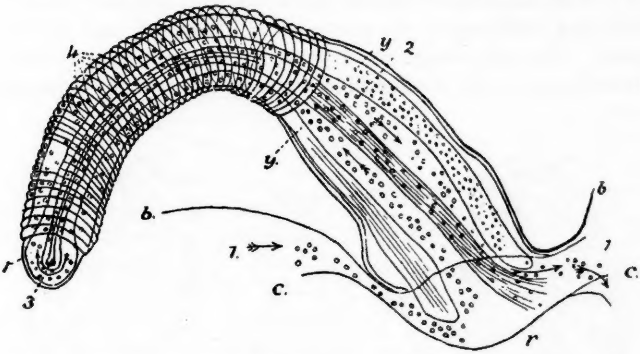


FIG. 46. Very young bud-tube, from a solitary Salpa: *b*, outer tunic; *c*, wall of pericardium; *r*, heart; 1, blood-channel; 2, cavity of tube; 4, constrictions upon the tube; *yy*, ovaries.

At this time our acquaintance with the lower invertebrates was increasing with wonderful rapidity, and it was soon found that several animals, especially the intestinal worms, go through an alternation substantially like that described by Chamisso as taking place in Salpa ; the second generation being very different in external form, and, in many cases, in structure also, from the first. Within a few years from the time of publication of Chamisso's account Steenstrup's work upon Alternation of Generations appeared, and so much additional information was given by this that this method of development was shown to be not even anomalous or exceptional, but common to whole groups of animals. Salpa also was soon made an object of especial study by several eminent naturalists, and Chamisso's account was confirmed in all essential particulars; and the able memoirs of Sars, Krohn, Huxley, Vogt, and Leuckart have given us a nearly complete account of its life history. All these naturalists agree in holding the opinion that Salpa presents a real

alternation of generations, as stated by Chamisso, and the history of its development, as given in their papers, is as follows : —

Each egg hatches into a single embryo of the solitary form (Figures 43 and 44). After this solitary Salpa has acquired most of the adult characteristics, but while it is still very small, part of the wall of its body becomes prolonged into a hollow tube, which is shown, very much magnified, in Figure 46. The cavity of this tube is in free communication with one of the blood-channels (1) of the mother, so that the blood can pass into and out of the tube and thus supply the material for its growth and development. The tube lengthens very rapidly, and as it grows it bends so as to pass round the digestive organs of the mother (Figure 44,

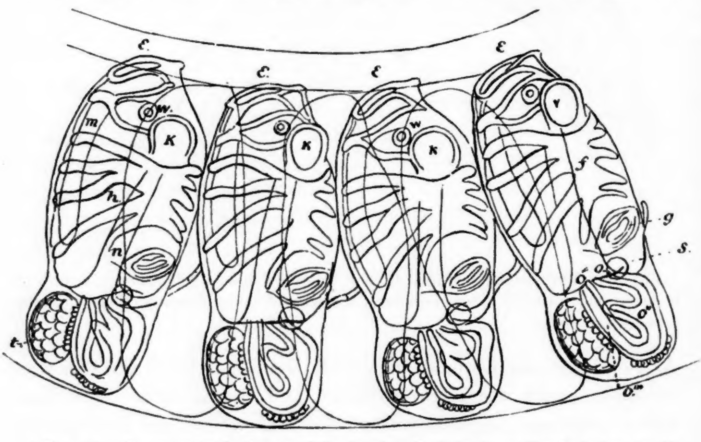
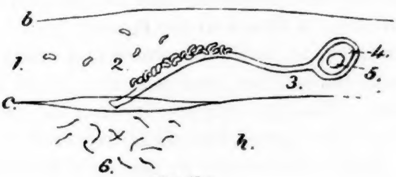


FIG. 47. Seven animals from a fully developed chain immediately before its discharge from the body of the solitary Salpa : *s*, egg ; *t*, testicle.

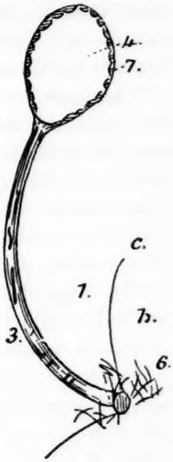
nu) in a spiral (*u*) which lies between these organs and the outer wall of cellulose. Meanwhile a series of constrictions makes its appearance upon the surface of the tube (Figure 46), and in a short time the spaces marked off by these constrictions assume the shape and acquire the organs of young chain-salpæ, as shown in Figure 44, *u*. The chain-salpæ then are produced by a process of budding from the body of the solitary Salpa.

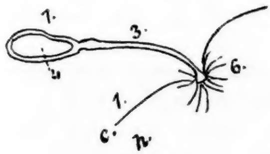
There are many hundred chain-salpæ thus marked off at one time upon the surface of the tube, but the forty or fifty nearest its free end develop much more rapidly than the rest, though uniformly as compared with each other. After their organs are perfectly formed, but while they are still very small, they become

detached from the tube and escape into the water as a chain, the animals of which are now able to provide for themselves and grow very rapidly. Meanwhile another set is developed upon the tube of the solitary form, to be cast off in turn, so that the



(Fig. 48.)

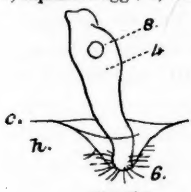




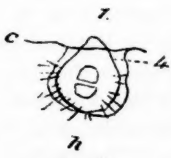
(Fig. 50.)

(Fig. 49.)

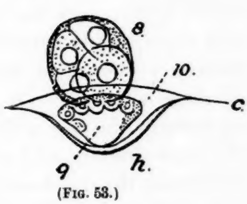
Fig. 48. Egg before impregnation.
Fig. 49. Egg during impregnation.
Fig. 50. The changes following impregnation: *b*, outer tunic of nurse; *c*, wall of breathing chamber of nurse; *h*, breathing cavity of nurse; 1, blood-channel of nurse; 2, blood corpuscles; 3, egg-stem; 4, yolk; 5, germinative vesicle; 6, spermatozoa; 7, capsule of egg; 8, nucleus.



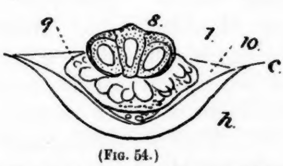
(Fig. 51.)



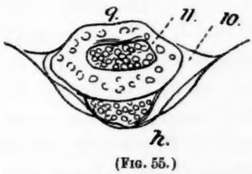
(Fig. 52.)



(Fig. 53.)



(Fig. 54.)



(Fig. 55.)

Figs. 51–55. Successive stages of segmentation: *c*, wall of breathing chamber of nurse; cavity of same; 1, blood channel; 4, yolk; 8, food yolk; 9, germ yolk; 10, orifice of blood sac; 11, invagination orifice; *h*, breathing cavity of nurse.

latter continues to set free chains from time to time, as they become matured.

The solitary Salpas themselves are produced in quite a different way. At the time the chain is set free each of its component animals contains a single egg (Figure 47, *s*) as well as a testicle (*t*), which is at this time immature and is composed of a mass of undifferentiated cells, as shown in the figure.

The eggs, on the contrary, are fully developed and ready for impregnation, which soon takes place, and is accomplished in a very remarkable manner. The egg (Figure 48) lies in one of the blood-channels (1) of the chain-salpa, which we shall hereafter call the "nurse." It is bathed freely by the blood, but is not itself free within the channel, being mounted upon a long stalk (3), like a cherry upon its stem, and the end of this stem is attached to the large chamber (Figure 45, *h*), which we have already described as filled with sea-water, and which we shall hereafter designate as the breathing chamber.

In Figure 48, *c* represents the wall of this breathing chamber, and *h* its cavity, which is open externally and is filled with water at each contraction of the muscular bands. As Salpa when found at all is very abundant, the water always contains plenty of full-grown chains, as well as the young and immature egg-bearing ones. The testicle in the full-grown chain-salpa is fully formed, and this discharges its spermatic fluid into the water, which accordingly contains great numbers of fresh and actively moving spermatozoa. Some of these are drawn, with the respired water, into the breathing chambers of the young nurses, and these may be seen to congregate at the point where the egg-stem is attached, as shown in Figures 48, 49, and 50. Some of these may be seen to penetrate the stem, and work their way up towards the egg, which is thus fertilized. After impregnation the stem shortens and swells as shown in Figures 49, 50, and 51, and draws the egg down into a "brood-chamber," or pouch, which is formed in the wall of the breathing chamber. The opening of this pouch still connects it with the blood-channel, of which its cavity is a diverticulum, so that the egg is still bathed and nourished on all sides by the blood, and increases in size very rapidly during segmentation, some of the stages of which process are shown in Figures 51, 52, 53, and 54. After the formation of the gastrula the blood not only bathes the outside of the embryo but also passes into and out of the gastrula mouth (Figure 55, 11).

A constriction now makes its appearance and divides the em-

bryo into two portions, of which the one nearest the blood channel of the nurse becomes developed into a true placenta (Figure 56, 12), similar, in function as well as in structure, to that of a

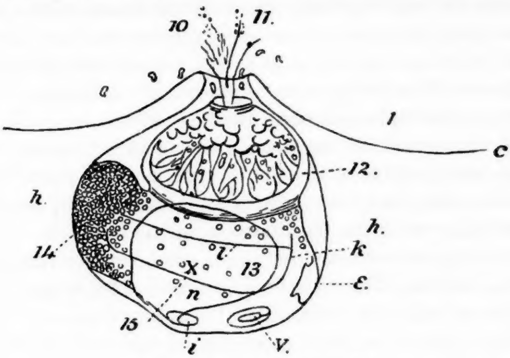


Fig. 56. Embryo of solitary Salpa.

fœtal mammal, while that portion which is directed towards the breathing chamber becomes developed into the embryo proper. This is nourished with the blood of the nurse by means of the

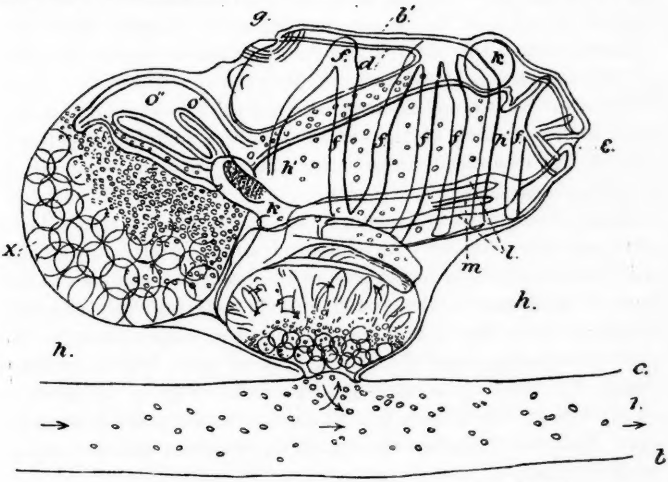


Fig. 57. Embryo more advanced, and ready to be discharged.

placenta, and grows very rapidly and soon assumes the characteristics of the solitary form. In Figure 57 an embryo is figured as it appears when development is very much advanced. It is

seen to be attached by a narrow neck to the wall (*c*) of the breathing chamber (*h*) of the nurse. In this figure, 1 represents the blood-channel of the chain-salpa, and the arrows show the direction of the currents into and out of the placenta. The presence of a true placenta in an animal so simple in structure and so far removed from the mammalia is such a remarkable and interesting instance of the independent appearance of similar structures that a short description of it will not be out of place. It is composed of two parts: an inner chamber in direct communication with the blood system of the chain-salpa, and an outer chamber surrounding the inner but entirely shut off from it, and in free communication with the blood system of the fœtus.

The blood globules of the fœtus are much smaller than those of the nurse, and may therefore be distinguished from them without difficulty, and after the heart of the fœtus begins to beat, it is easy to see that there is no direct mingling of the blood of the nurse with that of the fœtus, but simply a very close contact, exactly as is the case in the mammals. The large globules of the nurse can be seen to enter the inner chamber of the placenta, course around it through the intricate channels into which it is divided, and then leave it to return to the general circulation; while the smaller globules of the fœtus may be seen to make their way into and around the outer chamber, and then to return into the general circulation of the fœtus. Since the reversal of the action of the heart of the fœtus does not generally take place at the same time with that of the chain-salpa, the complete independence of the two circulations is very clearly shown when either of them is reversed.

After the embryo has acquired all the organs of the solitary form and has increased many hundred times in size, its attachment by the placenta to the wall of the breathing chamber of the nurse is broken, and the young animal falls into this chamber and lives there for some time, but finally escapes through the posterior opening into the water, and at once begins to form chains by budding, as already described. Figure 45 shows a nearly full-grown chain-salpa, which contains a solitary embryo, (*s*). This is free within the breathing chamber, and is ready to be discharged.

Figures 44 and 45 are drawn to nearly the same scale, Figure 45 being only a little more magnified than Figure 44. Figure 44 represents a solitary Salpa, which contains a chain, *u*, which is ready to be discharged into the water, while Figure 45 represents

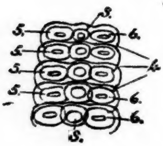
a chain-salpa, containing an embryo of the solitary form, *s*, which is also ready to be discharged. It will at once be seen, by a comparison of these figures, that although the two forms differ little in size when full grown, the solitary form is many hundred times larger than the chain-salpa at birth. After the embryo escapes from the body of the chain-salpa, the testicle of the latter becomes fully developed, and its spermatic fluid is discharged into the water to gain access to the breathing chambers of younger chain-salpæ and fertilize the eggs carried by these.

Such is the history of the two forms, as it has been traced by the distinguished naturalists already mentioned, each of whom has added portions of the process which had escaped the notice of the previous observers. Many other embryologists have contributed to our knowledge of the subject, but those mentioned have made Salpa the object of long and exhaustive research, and the summary of their observations may be stated as follows: The egg hatches into an embryo which becomes a solitary Salpa. Each solitary Salpa gives birth to chain-salpæ by a process of budding from the walls of a tube. Each chain-salpa contains a single egg, which undergoes internal impregnation, and forms a solitary embryo, which is nourished by a true placenta. The adult chain-salpa is furnished with a testicle.

From these statements, which are perfectly accurate, the conclusion has been drawn that Salpa presents an instance of alternation of generations. It is almost unnecessary to say here that this term is applied to the reproductive process of those animals among which the egg gives rise to a sexless animal which in time gives origin, by a process of budding, to sexual forms, which in turn reproduce the sexless form by eggs. The hydroids furnish well-known illustrations of this process.

Since in Salpa the eggs as well as the male fluid are found in the animals of the chains, while these are produced asexually as buds from the body of the solitary Salpa, it seems reasonable to conclude that the reproductive process in Salpa is similar to that of the hydroids, the solitary form being the sexless and the chain-salpa the hermaphrodite sexual form; and this view is now generally accepted. I have said that the account which I have given above, and which seems to fully support this conclusion, is strictly accurate; but it is not quite complete. A few of the early stages of development have escaped the notice of all observers, and these few stages put the whole matter in an entirely new light, for they show that the solitary Salpa is the female, and the

parent not of the males alone but of the eggs which they carry as well, and therefore of the embryos which these eggs produce. Although the chain-salpa gives birth to the solitary form, it is not its mother, but simply a nurse. It is not even the father of the egg which is fertilized within its body; although, after it has discharged its own embryo it may become the father of the embryos carried by other chain-salpæ. In order to explain this utterly anomalous and apparently contradictory manner of development, it will be necessary to trace a little more minutely the early stages in the formation of the animals which compose the chain. It will be well to call attention, in the first place, to the fact that no female animal or plant we know of has the power to form only a single egg or seed, and it is plain that if there were such an organism, it would gradually become extinct, since each


(Fig. 58.)

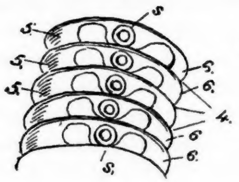

(Fig. 59.)

Fig. 58. Five Salpæ from a tube, at a very early stage of development.

Fig. 59. The same, still earlier: 4, the constrictions which mark out the animals; 5, ganglia; 6, digestive organs; *s*, ovum.

generation could be as numerous as the one before it only when every embryo survived all accidents and reached maturity.

The fact that the chain-salpa contains only one egg is in itself enough to excite a suspicion that it is not the true female; but in answer to this argument it might be said, fairly enough, that the whole history of Salpa is a series of anomalies, and that, since one more or less would not make much difference, there is no great difficulty in believing that it differs from all other animals in producing only one egg. It might be urged that indefinite multiplication is provided for by the power of the solitary form to produce large numbers of chains. As we trace back the development of the chain-salpa we soon find much stronger reasons for doubting that this is the parent of the egg which it contains. The sexual products are not usually matured until the animal has reached its adult form, and very few animals reproduce during their embryonic or larval stages; but almost immediately after the chain-salpa is born, and when it is less

than a fiftieth of its adult size, its egg is fertilized. Going back to a still earlier period we find that when the organs of the chain-salpa first begin to make their appearance upon the walls of the tube, each one contains a full-grown egg, as shown at *s* in Figure 58. At a still earlier period, when the only indication of the future chain-salpa is the constriction upon the surface of the tube, each space thus marked off contains a single, full-grown egg, which appears to be as fully ripe as at the time of impregnation. Figure 59 shows five of these constrictions at this time, and their eggs (*s*).

At a still earlier stage, before the constrictions appear upon the wall of the tube, this is seen to contain two large club-shaped bodies (Figure 47, *yy*), which under careful examination with high powers are found to contain germinative vesicles; and by patient examination of large numbers of solitary Salpæ at about this period, a few may be found which show that these bodies are made up of rows of eggs and are therefore ovaries, and the solitary Salpa must be regarded as the female, since the chain-salpa cannot be the parent of an egg which exists before the chain-salpa itself is formed.

We must therefore conclude that, instead of an instance of "alternation of generations," we here have simply a remarkable difference in the form and mode of origin of the two sexes, for we must regard the solitary Salpa as the female and the chain-salpa as the male. The life-history of Salpa may then be briefly stated in outline as follows: The solitary Salpa is the female, and produces a chain of males by budding, and discharges a single egg into the body of each of these before birth. These eggs are impregnated while the chain-salpæ are very small and sexually immature, and develop into females which give rise to males by budding. After the fœtus has been discharged from the body of the male the latter attains its full size, becomes sexually mature, and discharges its spermatic fluid into the water to gain access to the eggs carried by other immature chains.

It is worthy of notice that although Chamisso's announcement of the occurrence of alternation of generations among animals is thus seen to have been drawn from the study of animals which do not present an instance of it, this mistake has been of the greatest usefulness, since it has led to our knowledge of the numerous instances of true alternation which now form such a large and important chapter of zoölogical science. The relation in which Salpa stands to the other tunicates shows also that no

abrupt line can be drawn between alternation and ordinary sexual reproduction, but that they are different forms of the same process. In a future paper I hope to say a few words upon this subject, and to show how all the strange peculiarities of Salpa receive a simple explanation upon the theory that it is the descendant of an ordinary tunicate which has been modified by natural selection.

PLAIN, PRAIRIE, AND FOREST.

BY PROF. J. D. WHITNEY.

PART II.

THE more the prairies are studied, the less will one feel disposed to adopt any theory for their origin dependent on climate, and the more will the attention be turned to the question of the character of the soil, the distribution of the geological formations from which this soil has been derived, and the cycle of recent geological events by which it has been distributed and accumulated in its present position. It is evident, however, that in the discussion of a question of this kind full details of the observations made cannot be given; they would occupy volumes. It is for the observer himself, on carefully analyzing and classifying the results of his examinations, to state the conclusions at which he has arrived; a catalogue of the localities visited would be of little service to any one else in enabling him to form an independent opinion.

As the result of a great number of observations made over all the prairie States, we find, almost without exception, that absence of forests is connected with extreme fineness of soil, and that this fine material usually occurs in heavy deposits. It seems hardly necessary to enlarge on the characteristics of the so-called "prairie soil." To look at a plow with which the prairie has been broken up ought to be a sufficient indication of this fineness. How often has the writer admired the beautiful polish put upon this common utensil used on the western prairies, and contrasted its appearance with that of the scratched and battered article with which the hills of New England had been belabored. Let us, however, quote a few paragraphs illustrative of the nature of the prairie soil from some of the Geological Survey Reports, beginning with that of Illinois.

"All the part of the county [Boone, Illinois] south of the Kishwaukee may be called a treeless prairie, characterized by

long, low, undulating rolls and low ranges of hills and ridges. In some places it is flat, with swales and sloughs of limited extent, between moist marshes and black, fat meadow lands. A few trees skirt along Coon Creek, and scattered patches of timber in one or two other places relieve the level landscape. A broad, rich, comparatively level Illinois prairie, these hundred noble sections preserve yet some of that primitive beauty which gave two townships [Spring and Flora] their names. Before the busy teeming millions of the sons of toil swarmed over the fertile West, prairie flowers, in spring-like beauty and autumnal glory, bloomed where now the glancing plow-share turns the spring furrow, and the golden-ripened wheat-fields dally with the fugitive winds. The purple and golden clouds of flowers that used to lay on these prairies are now no more; but in their place the tasseled Indian corn waves its head, and men are growing rich from the cultivation in useful crops of these old flower-beds of nature." [1]

Again, from the Missouri Reports: "Timber is not very abundant in Saline County. . . . . Throughout almost its entire area, there is a deep, rich, black soil, of unsurpassed fertility. The ease with which these beautiful, rich, mellow prairie lands can be cultivated almost makes the toil of the husbandman a pleasure, while their freedom from rocks, roots, stumps, and other impediments enables him to use the various modern labor-saving agricultural implements with astonishing effect." [2] Next, from the Iowa Report: "The scarcity of timber has, doubtless, had much to do in retarding the settlement of this fine region [Ida County]. . . . . The soil throughout the county is mainly of bluff origin. It consists of a buff-colored, *exceedingly finely comminuted* silicious earth. The bluff formation overspreads the entire county, enveloping the uplands in a deep mantle of the peculiar silicious deposit of which it is composed. In the southern portion of the county it probably attains its greatest thickness, where it cannot be less than one hundred feet." [3] It seems hardly necessary to multiply quotations of this kind, as might be done to any extent. No person can have traveled through Southern Wisconsin, Illinois, Iowa, or Missouri, without having had everywhere occasion to notice the prairie soil and to find out what its characters are, and that, as a general rule, it is exceedingly fine and deep. There are whole counties in Iowa where

[1] Worthen's Illinois Report, v. 95.

[2] Reports of the Geological Survey of Missouri, 1855–1871, pp. 159 and 179.

[3] C. A. White in Geology of Iowa, ii. 163.

not a single pebble can be found; children are born and grow up without ever having seen a fragment of stone, a bowlder, or even a pebble large enough to throw at a dog.

If, then, this extreme fineness of the soil is the cause of the absence of forest growth, we ought to be able to explain, when looking at the facts from this point of view, that which from any other theoretical stand-point has seemed entirely inexplicable. The apparently eccentric distribution of the timbered tracts within the prairie, and of forest-covered patches in the midst of great treeless regions, — these conditions, which are evidently so little connected with absence or presence of moisture, and which seem so obscure, how clear they become when we examine the soil itself, instead of interrogating the skies and the rain-tables!

How, then, are the wooded tracts distributed in the prairie region? An examination of the maps before us, on which the prairies of Illinois, Wisconsin, Iowa, and Minnesota are designated, from materials collected at the General Land Office, shows clearly that, as a general rule, it is the higher portion of the country which is destitute of timber. All are probably somewhat familiar with the terms commonly in use at the West, "river-bottom," "bluff," and "prairie upland."[1] All are aware that the prairie country has, in general, a moderately undulating surface, and that the streams, which are very numerous, have sunk their beds to a depth of from a few feet up to two hundred or three hundred below the general level; that these valleys are often very wide in comparison with the size of the streams which meander through them, and that the ascent on to the uplands is not a gradual one, but usually rather steep, such steep ascents being universally known as "bluffs." These bluffs often, especially in Wisconsin, Northern Iowa, and Northern Illinois, exhibit outcropping edges of rocks, forming low, nearly perpendicular ledges, the geological formations lying almost everywhere in the prairie region in a nearly horizontal position, and consisting of nearly, if not quite, unaltered limestones, shales, and argillaceous sandstones.

As a general rule, the timbered tracts are found in one of two positions: either they stretch along the bluffs which border the river valleys, or they occupy patches, called groves, high up on the uplands, at a level of a few feet — rarely as much as a hundred — above the surrounding prairies. The river bottoms them-

[1] For a careful description of the surface in the prairie region, by the present writer, see Hall and Whitney's Geology of Iowa, 1858, vol. i., chapter 1.

selves are sometimes quite heavily timbered, but frequently treeless and covered with grass, and then known as "bottom prairies." In Illinois, of which State perhaps three quarters to two thirds are prairie, the wooded tracts are almost entirely in the river valleys or along the edges of the bluffs; the uplands, or rolling and nearly flat plains between the streams, are, to a large extent, destitute of timber. Very much the same condition of things exists in Iowa. Here, however, a considerable portion of the surface east of a line drawn in a northwesterly direction from the mouth of the Makoqueta River to the state line is pretty well timbered, while west of this there is a gradually increasing deficiency as we go towards the Missouri. All through the State, however, except in the northwest corner, there are isolated patches of timber on the upland, often forming beautiful and extensive areas of woodland. In Wisconsin the prairie region lies mostly to the north of the river of that name. Just along the river is a narrow belt of prairie, in interrupted patches. Then, twelve or fifteen miles farther south, comes an extensive and continuous prairie, stretching along from east to west and occupying the divide between the waters flowing into the Wisconsin and those tributary to Rock River. It was on this line of prairie that the famous "military road" was built by the government to connect Lake Michigan with the Mississippi, and which was once of so much importance. South from this east and west line of prairie run several broad patches of the same, gradually widening southwards, and occupying more than half the surface when we reach the Illinois state line. In the midst of these areas of prairie are fine groves of timber, quite dense, sometimes near a creek and sometimes far away from water. In the bend between the Wisconsin and the Mississippi, as the latter curves to the east just before passing Cassville, there is a beautiful, isolated prairie, about fourteen miles long and twelve wide in its widest part, having one large grove near its southeastern edge. Space is wanting to enable us to indicate all the peculiarities of the distribution and intermingling of prairie and timber from Minnesota to Arkansas; but the reader must surely have bcome convinced that inequality in the distribution of moisture offers no solution of the problem before us.

Let us turn, at present, to the geological side of the investigation. The whole of New England and New York, and a large part of Ohio and Indiana, together with the whole of Michigan and of Northern Wisconsin, constitute a region over which the

northern drift phenomena have been displayed on a grand scale. Consequently, almost the whole of this area is covered with heavy deposits of coarse gravel and bowldery materials. These deposits, if not at the surface, are near it, and the finer materials deposited on them, by alluvial and other agencies, generally form only a thin covering for the coarse deposits beneath. But as we go south and west from the region indicated above, we find the underlying rock — the "bed-rock," as the Californian miners would call it — deeply covered with loose materials, it is true, but we observe also that these are quite different in character from what they are to the north and east. We come to a region where the drift agencies have been very limited in their action. The bulk of the superficial detritus has been formed from the decomposition of the underlying rock, and this detritus has been but little disturbed or moved from its original position. If erratic deposits exist, they are usually deeply covered with finer materials derived from close at hand. A great area exists in Wisconsin and Minnesota over which not a single drift pebble has ever been found, either at the surface or at any depth beneath it. The strata have become chemically disaggregated and dissolved by the percolation of the rain through them, the calcareous matter has been carried off in solution, and there is left behind as a residuum the insoluble matter which the rock originally contained, and which, consisting largely of silica and silicate of alumina, forms by its aggregation a silicious and clayey deposit of almost impalpable fineness. It is this fine material which makes up the bulk of the prairie soil; and, as the writer conceives, it is this fineness which is especially inimical to the growth of trees. Exactly as we see the desiccated lakes in the midst of the forests gradually filling up with finely-comminuted materials and becoming covered with a growth of grasses or sedges, which is not afterwards encroached on by trees, no matter whether the ground becomes completely dry or whether it remains more or less swampy, so we have the prairies, which have certainly never at any time been overspread with forests, and which would always remain as they are, provided the climate underwent no radical change and they were not interfered with by man. It is for the vegetable physiologist to say why this fineness of the soil is unfavorable to the growth of trees; it is for the geologist and physical geographer to set forth the facts which they may observe within the line of their own professional work.

From the point of view here established it is easy to explain

phenomena which, if any other theory be adopted, seem to be entirely inexplicable.

The first question which occurs is this: Why are the prairies, or grassy plains in general, almost exclusively limited to areas which are comparatively level? No theories of climatic influence or unequal distribution of moisture seem to have any bearing on the solution of this question. But if we consider that in order to carry off the finest particles produced by the disaggregation of the rocks there must be currents of water having considerable velocity, we see that it is only in hilly regions that the soil will be washed out enough by the rapid flow of the streams to give rise to a soil sufficiently coarse to favor the growth of forests. Thus it happens that in the prairie region the growth of trees is so frequently limited to the bluffs which border the streams; it is because the inclination is sufficiently rapid to cause the water, as it finds its way down to the bottom of the valley, to take with it the finer particles which on the uplands remain undisturbed. When heavy rains fall, the water stands upon the surface in sheets and pools, and gradually soaks into the ground. For this reason the divides between the streams, where there is hardly any perceptible inclination of the surface, are occupied in preference by prairie lands. If the height of the bluffs be considerable and the eroding power of the stream sufficient to cut the country up into a succession of ravines with but little level ground between them, then the whole region will be more or less covered with timber, as is the case in Northeastern Iowa, although the conditions with regard to moisture are less favorable than in some other parts of the State. The groves of timber which stand isolated upon the prairie, in so many places, are found on examination to have grown upon coarser-soil than that which surrounds them; in some cases, the deposits of coarse drift have escaped being covered by the prairie soil because a little more elevated in these spots, or the increased height has favored the washing away of the finer particles. The railroads which run through Northern Illinois, where prairie soil and drift soil are constantly alternating with each other, furnish excellent sections from which one can see at a glance, as he crosses the country, how dependent the growth of the forests is on the character of the soil. One, even if blindfolded, could tell without difficulty, in the great majority of cases, by feeling the soil, whether he was in a timbered or a grassy region. Thus we see Mr. Winchell, in his description of the "Big Woods" of Minne-

sota, admitting that the soil is coarser and more gravelly than it is on the adjacent prairies, although he sees no connection between this peculiar character of the soil and the exceptional existence of an extensive forest upon it, while at the same time recognizing the dilemma in which he is placed by his adoption of the prairie-fire theory. The writer has often noticed, during his explorations just on the western edge of the Lead Region, that the vicinity of old, abandoned shafts was becoming overgrown with trees, the fact being that in the sinking coarser materials underlying the prairie soil had been reached and thrown out in abundance on the surface, and that it was on this gravelly detritus that the trees were growing, the adjacent, undisturbed prairie remaining in its natural, grassed condition.

The distribution of the timbered and prairie tracts in Wisconsin, as already suggested, illustrates beautifully the dependence of the forest growth on geological conditions rather than on those having to do with climate. In the northern part of the State, as we see indicated on Professor Brewer's map, is a region of dense forest, although, as the table of rain-fall statistics given on a preceding page [1] shows, this is not a region of large precipitation. It is, however, heavily covered with coarse detrital materials, plentifully distributed from the "head-quarters of the drift," on Lake Superior. The rocks underlying the drift deposits are crystalline, belonging to the Azoic series, and the surface is rough and broken, being intersected with low ridges, and knobs of granite and trap. South of this is a large area occupying the central portion of the State and extending down as far as the Wisconsin River, almost exclusively occupied by a very pure silicious sandstone, which is wrapped about the Azoic region, extending in a northeasterly direction to the Menomonee River, and northwest to the Falls of the St. Croix. This great sandstone-covered area is the pine district of the State, while south of the Wisconsin is the region of oak openings and prairies. And when we reach these treeless tracts, the range and extent of which have already been indicated, we find that we have got entirely beyond the drift-covered area, and that we are upon a soil made up of the insoluble residuum left from the disintegration of several hundreds of feet in thickness of limestone and dolomites, which have been dissolved out and carried away by the rain, there being abundant evidence that this region has never been covered by water since it was first raised above the Silurian

[1] See NATURALIST, x. 586.

ocean. Thus we find the distribution of forest and prairie in Wisconsin to be most intimately connected with the nature of the soil and the geological conditions under which this has been formed, while it has been clearly shown that climatic conditions were either absolutely null in their action or else entirely secondary to those other more potent ones which have been designated.

Were there space enough, it would be possible to show, with abundant detail of description, how, all over the prairie region, the characters of the soil and the surface harmoniously combine to favor or repress the growth of forests, regardless of the amount or distribution of the atmospheric precipitation. A thorough working out of the surface geology of Missouri or Arkansas would especially well illustrate the correctness of the statements which have been here advanced, and the inferences which have been drawn from them.[1]

It remains to say a few words in regard to the views of Mr. Lesquereux. He, if we have correctly apprehended his theory, ascribes the existence of the prairies almost exclusively to the character of the soil. But he conceives this unfittedness for tree-growth to be, in some way not clearly apprehended by the writer, due to the "agency and growth of a peculiar vegetation." If we are not mistaken, the essential points of the theory of Mr. Lesquereux are — and, as far as possible, we will use his own words in setting it forth — "that all the prairies of the Mississippi Valley have been formed by the slow recess of sheets of water of various extent, first transformed into swamps and by and by drained and dried;" the soil thus formed "is neither peat nor humus, but a black, soft mold, impregnated with a large proportion of ulmic acid, produced by the slow decomposition, mostly under water, of aquatic plants, and thus partaking as much of the nature of the peat as of that of the true humus;" these plants "contain in their tissue a great proportion of lime, alumina, silica, and even of oxide of iron, the elements of clay. Moreover, this vegetation of the low, stagnated waters feeds a prodigious quantity of small mollusks and infusoria, whose shells and detritus greatly add to the deposits. The final result of the decomposition of the whole matter is that fine clay of the subsoil of the prairies, *which is indeed truly impalpable*, when dried and pulverized and unmixed with sand."

[1] Mr. Gabb has shown (see American Journal of Science (3), ii. 127) that in Santo Domingo "the grass and tree regions are sharply defined, and correspond in the main with certain geological features."

The writer has taken the liberty of italicizing a few words in the last sentence quoted from Mr. Lesquereux,[1] in order that the reader may not fail to notice that there is an essential agreement between us on the main point, which is that of the fineness of the prairie soil. That is to say, the main point in the opinion of the writer, but apparently not in that of Mr. Lesquereux, for he says, in speaking of the absence of trees as being caused by the fineness of the soil, "This explanation, I think, cannot satisfy the mind." When, however, we seek in his chapter on the prairies for the essential thing which does bring the desired mental satisfaction, we do not find it clearly stated, unless it be in the following sentences: "It is easy to see why trees cannot grow on such kind of soil [namely, the prairie soil, as described above]. The germination of seeds of arborescent plants needs the free access of oxygen for its development; and the trees, especially in their youth, absorb by the roots a great amount of air, and demand a solid point of attachment to fix themselves. Moreover, the acid of this kind of soil, by its particularly antiseptic property, promotes the vegetation of a peculiar group of plants, mostly herbaceous." That is to say, the soil formed by the decomposition of aquatic plants is unfavorable to the growth of forests, not only on account of its fineness, which must certainly at least assist in preventing "the free access of oxygen," but also because its chemical qualities are such as especially favor herbaceous vegetation.

That some portions of the prairie soil may have been formed by the decomposition of aquatic plants in the manner suggested by Mr. Lesquereux we are not disposed to deny, although not aware that it has yet been proved by chemical investigation that such a soil is chemically unfitted to support the growth of forest trees. We are, however, still disposed to adhere to the statement made in the Wisconsin report (1862), that "the great mass of superficial clay, loam, and other loose materials lying on the solid rock in this region [the Lead Region of the Upper Mississippi, a prairie country] is simply the residuum left after the more or less complete solution and removal of the soluble portion of the rock."[2] That the prairie soil proper is not, as a general rule, or necessarily, a soil containing a large amount of

[1] Geology of Illinois (1866) vol. i., chap. vii., Onthe Origin and Formation of the Prairies.

[2] See Wisconsin Report, chapter iii., on the Physical Geography and Surface Geology of the Upper Mississippi Lead Region, by the author of the present article.

organic matter, seems to us clear. A large quantity of such material does collect, it is true, in the swampy places and low swales between the ridges or swells of the prairies; but it must be remembered that the higher grounds — the divides between the streams — are *par excellence* the regions of prairie. And it would be extremely difficult to prove that these higher grounds have ever been occupied by an aquatic vegetation. The extensive district in Wisconsin and Minnesota which has never since almost the earliest period of geological time been covered by water,[1] and which is as far as possible from being of a swampy nature, is thoroughly a prairie region, as has already been described.

The series of events in the course of which the detrital materials covering the greater part of the States bordering on the Mississippi have been distributed and arranged in their present position must have been a long and complicated one. We know that the ocean has had nothing to do with it, for not a trace of anything marine has ever been found in these deposits, while bones of land animals and fresh-water shells and plants are not unfrequently met with. When we consider that in going west from the Mississippi we rise to an elevation of more than a thousand feet above the river, while all the time the prairie soil maintains its character, it becomes evident that we cannot admit that deposition of this detrital matter took place in the same manner and at the same time from one vast area of fresh water. No possible barrier for this water could be found in any direction except to the west, for to have covered the whole prairie region its surface must have been nearly 2000 feet above the sea-level. Everything in the prairie region indicates the slow and, as a general rule, tranquil accumulation of detrital materials during a vast period of time, and as the result of agencies rather local than general, having more of a fluviatile than of a lacustrine character, and which must have been in operation for a long time before the glacial epoch commenced. The discussion, however, of the phenomena here alluded to would extend this paper far beyond any reasonable limits.

Those who are familiar with the geology of the Mississippi Valley will not need to be told that the prairie region is one underlain by undisturbed and nearly horizontally stratified rocks. They will remember that these rocks are chiefly limestones, dolomites, and shales, easily acted on by water, the bulk of the material being bodily removed in solution, and not left as a disin-

[1] See Wisconsin Report, page 118, et seq.

tegrated mass on the surface, as is the case with the harder metamorphic rocks. These are the conditions specially favorable to the development of prairies; and it is under these conditions that prairies, in the Western sense of the word, are usually met with.

A few words may be added for the benefit of those who are disposed to put confidence in the stories told by persons having land for sale at the West, in regard to the ease with which forest trees may be raised on the prairies, some even going so far as to maintain that building a fence and keeping out the prairie fires is sufficient to insure the speedy covering of the land thus protected with a growth of timber. The best answer that can be made in a few words to these assertions is to quote from a pamphlet published by a practical man, Mr. Leonard B. Hodges, Superintendent of Tree Planting of the Saint Paul and Pacific Railroad Company. His object is to urge the importance to the West of raising forest trees; and does he say, "Fence in your land, gentlemen farmers, and your forests will develop themselves"? Quite the contrary; he especially dwells on the point that even setting out the trees will not answer, unless the land has been properly prepared. To use his own words, "without this thorough preparation, failure and disappointment are inevitable." So arduous a task is it to raise forest trees on the prairies that the State of Minnesota passed a law in 1871 granting a bounty of two dollars a year per acre for ten years and for every acre planted with "any kind of forest trees except black locust;" and Congress has gone further by actually giving to any settler the land, to the extent of forty acres, on which he will maintain a growth of forest trees for ten years. These provisions will, we think, convince any one that raising timber on the prairies is not so very easy a matter, but rather something "going against the grain" of nature.

There are persons to whom the position of the plains with reference to the prairies will be a decided stumbling-block in the way of their acceptance of the views above advanced. They will say, "Do not the plains begin where the prairies leave off, and are not the latter simply the incipient stage of the former? Do we not find the amount of precipitation growing gradually less as we approach the Rocky Mountains in going from the Atlantic coast, and are not the prairies simply the result of this deficiency, manifesting itself in only a partial covering of the surface of the forests?" This does indeed seem very plausible as long as one has not examined carefully into the facts; let us con-

ceive that what was set forth in the first portion of this article will have been abundantly sufficient to disprove the existence of this assumed want of moisture in the Mississippi Valley. If the drift agencies had covered the whole of the prairie States with coarse detritus, as they have the region to the north and northeast; then, in the opinion of the writer, forests would have clothed the whole country, as far west, perhaps, as the western border of Iowa; but from there on, no matter what the condition of the surface, they would not have extended themselves, because of the deficiency of moisture, the decrease being a very rapid one from the 94th meridian towards the west. On the other hand, there is nothing in the geological conditions of the surface in the region of the plains to prevent a forest growth, provided the climatological conditions were favorable, a complete change taking place in the character of the formations soon after we enter Nebraska and Kansas, the Cretaceous and Tertiary rocks covering up entirely all the older strata; and as they consist almost exclusively of coarse arenaceous materials, they furnish by their decomposition a soil very different from that of the prairies. If, again, the topography of the country was such that the warm and moist winds could not blow from the Gulf of Mexico up the valley of the Mississippi, causing as they go an abundant precipitation, then that region would be a sterile one, instead of being, as it now is, one of the most favored agricultural areas of the world, albeit not everywhere clothed with forests.

HYGIENE OF HOUSE PLANTS.

BY GEORGE H. PERKINS, PH. D.

ARE plants growing in occupied rooms injurious or beneficial to the health of the occupants? This is a question often asked and often answered in a very general manner; but it does not seem to be always easy to give specific reasons for a belief in the value or worthlessness of the influence of cultivated plants upon the air immediately about them. As full and satisfactory a reply to the question we have asked as can be given is of considerable importance, now that plants are found growing in a large majority of homes all over the country, and to furnish a reply is the object of this article. Although the writer is conscious that it is not by any means all that could be desired, he yet hopes that it may not be wholly useless to many lovers and cultivators of plants.

A group of plants is so attractive and so interesting in its form and development, that we would gladly be sure that its presence contributes as much to the health of a room as to its beauty. An entirely satisfactory investigation of this matter is scarcely possible, for analyses of air, careful experiments, and observations relating to the influence of plants growing in occupied rooms, are for the most part wholly wanting. The general effect of vegetation in the economy of nature is too wel known to be dwelt upon here. Most are familiar with the fact that animals are dependent upon plants for food, and that after growth, reproduction, and death, the materials of animal structure return to the vegetable, and thus everywhere, in ever-recurring cycles, the dead animal returns to life in the plant; everywhere, for vegetable life is everywhere, rooted in earth, floating in water, buoyed in air, and everywhere attractive, varied, and interesting. What is said in regard to plant life and growth in this article refers only to the higher and flowering plants. Such plants often remove much from both the earth and the air in which they grow, and in return they give much to the air; but while living they return almost nothing to the earth, only now and then a stray leaf or bit of branch. Hence, growing plants tend to change the nature of both soil and air. The chief processes of plant life, absorbing, assimilating, exhaling, are carried on with immense energy. *How* great these forces are we do not yet know, but experiments, such as those of President Clark, of Amherst, have lately been made, which have given us glimpses of the power exerted in vegetable growth. Without direct proof of the fact few would be ready to believe that the outward pressure of sap in a tree could ever equal that of a column of water over eighty feet high; that even in a bit of root wholly severed from the tree, though of course only recently cut off, the force of the sap-pressure could be as great, or that in a squash-vine it could equal that of a column of water nearly fifty feet high. No one, I think, would have supposed that a growing squash in its efforts to increase, would, when confined, lift a weight which was gradually increased to one ton, then to two tons, and finally to two tons and a half. These experiments are so well known that an account of them is unnecessary here, but they tell us very much of the forces acting in vegetation, which are so silent and imperceptible that we too often fail to notice them. In every field of growing grain chemical changes are taking place such as no chemist can produce; forces are in action which, if so directed, could heave

and overturn the soil as by an earthquake. We are learning to look for power in its fullest development, not so much in the more noisy phenomena that all observe, as in those unobtrusive, noiseless processes, unseen save by the eye of science, that go on all about us. In raindrop and snowflake, in forming leaf and opening bud, we are taught to look for force greater than we can know. In the rush of a landslide, as it crushes and overturns everything in its way, all recognize vast power; but all do not know that in the growth of every tree that lies crushed in the pathway of those rock-masses more force was expended than would be needed to hurl them whence they came. It is well known that the leaves of plants exhale moisture, but it is not so well known how much various plants give to the air. The amount varies almost constantly, being affected by temperature, dryness of air, amount of light, and condition of the plant. But the amount of water given to the air during a season by plants, is very considerable. A French botanist found that an oak exhaled in one season eight and a half times as much water as fell in rain over an area equal to that of the leaves. And other similar experiments give similar results.

The well-known process of taking carbonic acid from the air and returning oxygen to it, fixing the carbon in the tissues of the plant, has been shown by Bernard and others to be a true digestive and assimilative process, while all the time a true respiratory process is carried on by which oxygen is taken and carbonic acid given out. During the day, when the leaves are subject to the action of light, both these processes go on, but the assimilative process is vastly the more energetic and conceals the other process wholly. When light is withdrawn the respiratory process comes into prominence, because of the almost or entire cessation of the other, so that the action of plants by night is said to be the reverse of that by day, and so it is practically; but it is to be remembered that the most vigorous and important action of the plant, that which alone exerts any very marked influence upon the surrounding air, is that by which carbonic acid is taken from the air and oxygen given back. The relative activity of these two processes varies at different times of the year, as Corenwinder has shown that when the leaves expand they contain a large proportion of nitrogenous matter, which decreases gradually until autumn, while as the leaves become fully developed the carbonaceous matter increases, at first rapidly, then more slowly, and after a time it remains fixed until towards autumn, when it

decreases. So long as nitrogenous matter is in excess carbonic acid may be given off, but when the carbonaceous matter is in excess, whatever carbonic acid is set free is at once taken up by the chlorophyl and the carbon fixed, the oxygen being set free; and this latter is the great work of plants. So great are its effects that it is believed that they wholly counteract the vitiating influence of the billion pounds of carbonic acid which are, as is estimated, annually sent into the atmosphere; and throughout all the geological ages, since the development of plant life in its higher forms, it has been taking carbonic acid from the air, fixing the carbon and restoring the oxygen. Every pound of coal in all the two hundred thousand square miles of coal area in North America, represents three and two thirds pounds of carbonic acid taken from the air.

It can make but little difference where plants grow; those conditions which are essential to their growth must be met. If forests purify the air about them, it is reasonable to suppose that smaller groups of vegetation in our houses will purify that about them. There are indeed some plants that revel in filth and noisome vapors, but they are not such as will be found in our houses. Modern plants are many of them unable to endure even a slight increase in the amount of carbonic acid in the surrounding air, and we are forced to suppose that the plants of the coal period were peculiarly fitted for the atmosphere in which they grew. It has been found that many gaseous and other substances affect animals and plants in a similar manner, and in many cases an atmosphere in which one will not thrive is hurtful to the other. Many injurious gases that are too often found in our dwellings affect plants even more readily than they do man, so that to a certain extent plants become tests of the air we breathe; and when it is found that plants will not grow in a room because of gas from chandelier or furnace, it is surely true that such rooms are unfit for man's occupation, and that they cannot be used without certain injury to the health. In greenhouses, where a large number of plants are shut up in a small amount of air, it is true that the amount of carbonic acid is, even at night, less than outside. Florists, who spend much of their time in greenhouses, are as a class unusually healthy, and sometimes these people sleep for weeks in the greenhouse, with not the least evil effect. Physicians who have had much experience among florists have uniformly testified to their general robustness. It is also a well-known fact that asthmatic persons often

find great relief as they enter a greenhouse and breathe its air; even those whose complaint prevents comfortable rest elsewhere find little or no trouble in sleeping in a greenhouse. Thus all the facts at our command tend to prove that the air of greenhouses, despite its exceeding dampness, is not unhealthy, but rather the reverse. Luxuriant vegetation growing in very moist air is not *necessarily* so unwholesome as is usually supposed. Mr. Bates, in The Naturalist on the Amazon, speaks of certain localities in which he spent some time, where the air was as if filled with steam at times, and always very full of aqueous vapor, and where the vegetation was wonderfully rank; and yet he found these places unusually healthy, free from many complaints common in drier regions near by. This is perhaps an exception, rather than an example illustrating a general rule, but it is worth some notice.

If house plants are to thrive, they must have abundance of fresh air and sunshine. And now that fine window plants are so generally desired, there is doubtless often a severe struggle in the mind of many a housekeeper, to decide whether the plants shall suffer and perhaps die, or upholstery and carpets be allowed to fade. The plants seem usually victorious, the windows are opened for more pure air, the shutters for more light, and the home becomes more cheery, attractive, and healthful. The air heated by stove, furnace, or worse, by steam-pipes, is almost sure to be very dry, so much so as to be irritating and hurtful to the respiratory organs. As has been noticed, the leaves of plants exhale moisture, often to a considerable amount, and a dry air, if brought into contact with growing plants, is furnished with some of the lacking aqueous vapor. This process is, to a certain extent, self-regulating, for the drier the air the more rapid is the exhalation from the leaves, while this decreases as the moisture of the air increases. Another effect which might have considerable influence upon greenhouse air, but would not amount to much in occupied rooms, where but few plants are kept, is their tendency to equalize the temperature. In most cases plants do not rise in temperature as quickly as does the air about them, and while the air grows warmer during the day, and is at its maximum several hours before sunset, plants go on increasing in temperature for some hours after the air has begun to grow cooler, and thus as the air cools the radiation from plants warms it, while during the day the exhalation of moisture tends to cool the air. Thus far we have considered vegetation only in its ordinary

growth, but after this has continued until the plant has sufficient vigor, it produces flowers and fruit, unless it belong to one of the lower orders. Now the usual conditions may be somewhat changed; the temperature of the plant rises ten or more degrees above that of the surrounding air, and as flowers expand, carbonic acid passes off and oxygen is taken up, but in most cases this is not of such extent as to be important.

A greater effect is that of the odors which some flowers possess. We have very little positive knowledge of the nature of the perfumes of flowers. We know that powerful odors affect some persons unfavorably, at least at the time they are inhaled, causing nausea and faintness. We know that hydrocyanic acid and other deleterious substances exist in some odors, but I believe that all odors from plants which are known to contain injurious substances are disagreeable and repulsive. It seems possible at least that intense odors, such as that of the tuberose or many lilies, if inhaled for a long time would prove harmful, while the more mild odors are not so. There is very good authority for the assertion that many plants, such as the lemon, mint, hyacinth, heliotrope, mignonette, etc., when in bloom, in some way increase the quantity of ozone in the surrounding air, and are in this way beneficial. The common sunflower is said to be very useful in this way, and to do very much to counteract the effect of miasmatic vapors in its neighborhood. Those resinous odors which come from coniferous trees are agreeable to every one, and are generally believed to be wholesome and remedial. The blue-gum (*Eucalyptus*) of Australia emits camphorated and antiseptic vapors which have been found of great value in malarial regions. On the whole it seems probable that the perfumes of most of our house plants are not very powerful for either good or evil, but that they are quite as likely to be beneficial as the reverse. If decaying leaves or other such débris are allowed to remain on the surface of the pots, they may vitiate the air; but aside from this it is not probable that injurious gases can come from decomposing material in the earth of the pots, for the plant and the earth together act vigorously to prevent any such thing.

We conclude, then, that house plants are injurious only as they increase the carbonic acid in the air, and as they give out injurious perfumes. We have found that the first of these effects is certainly far more than counterbalanced by the taking up of carbonic acid and the throwing out of oxygen, and the second is also probably fully neutralized. House plants are positively useful,

as they pour aqueous vapor into dry air, as they demand plenty of light and air, and on this account many a room, otherwise dark and unwholesome, is well lighted and aired. One of the most powerful and important influences of cultivated plants yet remains to be noticed. Thrifty plants are always beautiful, and their growth and development always instructive and interesting; and the constant presence of such objects in our homes is obviously of very great value. We learn to love a favorite plant, and its influence makes our lives gentler and less gross and material; we may not always appreciate this effect, but it is ever acting and ever powerful. Hence, were there no appreciable physical good to come from the groups of plants that are so commonly seen in our windows, this moral benefit should make us encourage in every way their cultivation, and rejoice that it is already so general.

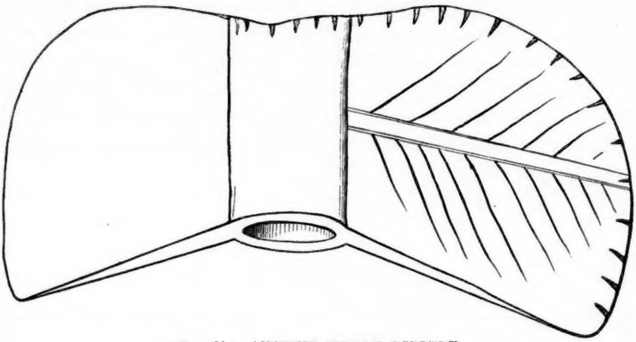
AN ANCIENT SCEPTRE.

BY C. C. ABBOTT M. D.

WHILE the Indians were in undisturbed possession not only of the Atlantic coast of North America, but of a great part, if not the whole, of the interior, they were not politically one people, but divided into many tribes, some of these again being in league, as the Iroquois "nation." These political divisions and subdivisions indicate necessarily the prevalence of rank, and the authority of certain individuals over large and small communities; this again leads to the necessity of badges, or insignia of office. Now among the many relics of the red man that we gather from our fields there occur some specimens which would be veritable puzzles, were it not that we do know something of the past history of the Indians. Among these peculiar forms is that called here a sceptre (Figure 60). These vary much in outline, yet preserve sufficient uniformity to warrant our classifying them as one form.

In many archæological works, and shorter essays on the relics of a circumscribed locality, this exclusively North American pattern is called a perforated ax, a term which for many reasons I believe to be entirely inapplicable; for there has yet to be discovered a single specimen that is adapted to cutting any substance as hard as wood. If any tool, it is a knife for skinning and allied uses; but as an abundant supply of stone implements occur, the world over, that are known to be knives, hatchets,

adzes, and axes, it is beyond question that these perforated specimens of stone work are either simply ornaments or badges of office. My reasons for believing them to be the latter are, as already stated, their comparative rarity, the absence of all indication of their having been put to any use whereby portions of the surface are worn or chipped off, and thirdly, that when found in graves they are associated with other elaborate relics, that of themselves give evidence of the rank of the person buried.



(FIG 60.) ANCIENT INDIAN SCEPTRE.

The variation of form, too, may be mentioned as indicative of the ornamental or badge-like character of the implement, the shape of the "wings" never approaching a tool-like appearance, but varying in the direction of the fantastic,[1] so that many are miniature pickaxes, or double picks. On the other hand, the central tube may be quite long, and the broad "wings" give the specimen a heart-shaped outline. Such specimens, however, may really not be sceptres, but winged medicine tubes, that the Indian physician used in sucking or blowing away the disease afflicting his patient.

The specimen here figured is doubly interesting, from the fact that one portion is scored with a series of notches about its margin, which add, I consider, great weight to the suggestion that these implements are banner-stones, or badges. I prefer the term "sceptre." Marginal notches such as here shown in Figure 60 are records of some one event, frequently repeated; in this case, possibly of successful wars with a hostile tribe, or of the personal prowess of the owner of the badge. The additional ornamentation, simulating the veining of a leaf, too, may have some such meaning.

[1] Stevens's Flint Chips, American edition, page 506.

An interesting fact in relation to this form of Indian relic is that it is quite as characteristic of the Mound-Builders as of the Atlantic coast natives. As it is a peculiar form of stone implement, and not one that is likely to occur with two widely separated and very different races, it argues a nearer relationship of the Mound-Builder and the Indian than is supposed by many to have existed.

In the specimen here figured [1] we see a highly polished and nearly symmetrical worked stone, suggestive of no domestic use, and valueless as a weapon or hunting implement. Its whole appearance indicates that a vast amount of labor has been expended upon it; furthermore, it is quite elaborately ornamented. Again, the perforation shows that it was mounted upon a slender handle, and thus wielded it becomes intelligible as an indication of the superior rank of its possessor — possibly a veritable sceptre in the hands of a prehistoric American king.

THE GREAT SALT LAKE IN FORMER TIMES.

THE Great Salt Lake of Utah was discovered in 1833 by Captain Bonneville, although his account of it was not published until ten years later by Washington Irving in The Adventures of Captain Bonneville, U. S. A., in the Rocky Mountains and the Far West. It was more fully described afterwards by Frémont and Stansbury, though but little light has been thrown upon the early history of the lake, until within a few years. In his report on the geology of Wyoming and contiguous Territories, for 1870, Dr. F. V. Hayden thus describes the lake beds and appearance of Great Salt Lake in the Quaternary Period: —

" If now we pass to what may be called for convenience the quaternary period, or the one that gradually merges into the present, we shall find that it presents geological features of no ordinary interest. In descending the Weber Valley, after we emerge from the cañon of the Wahsatch range into the open valley of Salt Lake, we observe on either side thick beds of sand and arenaceous clays, which must have been deposited in the quiet waters of a lake. In the valley of Salt Lake, and especially in that of the Weber River, these drift deposits possess a

[1] This specimen was found by Prof. S. S. Haldeman, in an island in the Susquehanna River, Pennsylvania. The illustration is a reproduction of a pen-sketch, in a letter to the author, referring to Indian relics found in Pennsylvania.

thickness of several hundred feet, and of these materials the terraces are formed. Near Salt Lake City, in digging a well, fresh-water shells were found in these deposits, forty feet below the surface; and on the north side of the lake, where these deposits are very largely exhibited, the cuts in the railroad, through the gravel and sands, reveal the greatest abundance of fresh-water shells, showing that at this time the physical conditions were unusually favorable for the existence of fresh-water molluscous life. So far as I could ascertain, these conditions do not exist at the present time, or if they do, it must be only to a limited extent. From these observations I infer that a vast fresh-water lake once occupied all this immense basin; that the smaller ranges of mountains were scattered over it as isolated islands, their summits projecting above the surface; that the waters have gradually and slowly passed away by evaporation, and the terraces are left to reveal certain oscillations of level and the steps of progress toward the present order of things; and that the briny waters have concentrated in those lake basins, which have no outlet. The entire country seems to be full of salt springs, which have, in all probability, contributed a great share to the saline character of the waters."

Additional information concerning the geology of the lake has recently appeared in the report of Mr. G. K. Gilbert, of Wheeler's Survey of the Territories West of the One Hundredth Meridian. We shall attempt, with the aid of liberal extracts from this interesting report, to give some account of the ancient history of this great briny lake, which in past ages extended over such a large area and formed one of a series of vast inland lakes rivaling in size the present great lakes of the northern border of the United States. These ancient lakes lay in the depressions of the Great Basin, as it was called by Frémont, situated between the Rocky Mountains and the Sierra Nevada.

The Great Salt Lake occupies the eastern portion of the Great Salt Lake Desert, which is divided from the Sevier Desert by a series of low ranges. These hills or insular buttes appear to have been, as it were, submerged beneath a sea of detritus. "If these hidden mountains rise as high above their bases as do their neighbors on the rim of the basin, we may, by comparing summits with summits, learn something of the relative depression of the rocky bottom of the basin below its margin; and it would appear, judged in this manner, to be not less than four thousand feet. And, on the same supposition, the desert sediments, which,

before burying the mountain ridges, have filled the intermediate valleys, may have a maximum thickness of five thousand or six thousand feet. Their upper surface, water-laid and smooth, is the broad floor of the desert, from which arms stretch north and south between the fringing mountains. In longitude the plain measures a little over a hundred miles, and in latitude a little less. Its general level is about 4200 feet above the ocean, and Great Salt Lake probably occupies its greatest depression, though lying close to its eastern border. Its surface material is a fine adhesive, absolutely sterile clay, charged with chloride of sodium and other soluble salts, the deposit from the last expansion of the waters of the lake, an expansion so recent that the beach-lines formed at its culmination and during its slow subsidence are perfectly preserved on the shores of the desert.

"The eccentric position of the lake is evidence of the novelty of the present relation of altitudes of different portions of the plain, which is far from an equilibrium. Nearly the whole present increment to the desert floor comes from beyond the Wahsatch Mountains, and is deposited in the deltas of the Jordan, Weber, and Bear rivers, on the eastern margin of the lake. Since the lake has no outlet, but parts with its surplus by evaporation, its area rather than its level tends to constancy; and, as the eastern shore increases, the water will rise, *pari passu*, and encroach on the western. The continuation of this process, if there is no counter influence, such as a secular depression of the lake basin, will push the water, in a few thousand years, to the western side of the desert."

Having considered the lake as it is at present, let us look at its past history as elucidated by Mr. Gilbert. He considers, from a study of the sediments and ancient beaches, that the Great Salt Lake formerly included the valleys now occupied by Sevier and Utah lakes, and he calls the hypothetical ancient body of water Lake Bonneville. "The most conspicuous traces of Lake Bonneville are its shore-lines. At their greatest expanse the waters rose nearly one thousand feet above the present level of Great Salt Lake, and at this and numerous other stages marked their lingerings by elaborate beaches and terraces. These are very conspicuously displayed on the slopes of the Wahsatch range near Great Salt Lake, and on the rocky islands of the lake, and have attracted the attention of every observant traveler from the time of the explorations of Frémont and Beckwith. All the varied products of wave-work, as we know them on modern shores, are represented and beautifully preserved."

The ancient beaches, or "benches" as the inhabitants call them, which indicate the former levels of the lake, at once attract the attention of the traveler soon after he leaves Ogden for Salt Lake City. "While some of the benches are better marked than others, no number can be assigned to the successive shore-lines from the highest to the modern. Upon gentle slopes many more can be detected than on steep, and they are of all grades of distinctness. It is doubtless true that some, which are at certain stations conspicuous, as compared to others, are elsewhere, from local causes, inconspicuous; but there are two lines that can, at nearly every point, be recognized as far more strongly traced than any others. One of these is the highest of all, the Bonneville beach. The other occurs about three hundred feet lower, and this we have found it convenient to entitle the Provo beach, drawing the name from the town of Provo, on the shores of Utah Lake, near which it is especially well exhibited. These tell us that, during the progressive subsidence recorded by the entire series, there have been two marked epochs, perhaps many thousands of years in duration, through each of which a constant water level was maintained. The level of Great Salt Lake, like that of other lakes without overflow, is notoriously inconstant, for the obvious reason that it depends on the ratio between precipitation and evaporation over a limited area, factors which diverge, and change their conditions of equilibrium, with every fluctuation of annual mean temperature or humidity. It is difficult to imagine that so unstable a climatal equilibrium was maintained for the time that was consumed in the production of either the Bonneville or the Provo beach, and, before we accept such explanation of their origin, we are led to inquire whether at these levels the stage of water was not regulated by an overflow. The coincidence of one of the constant levels with the highest water stage of all renders the presumption of an outflow at that stage especially strong. With these considerations in view, we endeavored, in tracing the outline of the lake, to discover its point of discharge, but without success. Our examination was almost exclusively confined to the southern half of the lake, and points to the conclusion that no outlet existed toward the Colorado River. At one low point of the southern rim, near Hebron, Utah, the observation was not so complete as was to be desired, and the question may be considered as not definitely settled. Prof. O. C. Marsh informs me that he has discovered, on the northern shore of the lake, an outlet leading to the Snake River,

but I am not aware at what point, nor at what altitude. The northern portion of the lake area falls within the fields of study of the corps of Mr. King and Dr. Hayden, and when their observations and those of Professor Marsh shall have been published, the relation of the beaches to the outlet or outlets will doubtless be known. Meantime I anticipate that the Provo beach, as well as the Bonneville, will be found to have been determined by an overflow.

"The largest open body lay over the Great Salt Lake Desert, and had a depth of about nine hundred feet. The average depth of the whole was not far from four hundred feet, and the extreme depth one thousand feet. Its area was not far from eighteen thousand square miles, being a trifle less than that of Lake Huron, and eight times as great as Great Salt, Utah, and Sevier lakes combined. Its extreme length, from north to south, was about three hundred and fifty miles, and its width one hundred and twenty-five miles."

Mr. Gilbert then describes the beds containing shells deposited by this ancient lake, and discusses the question whether the lake was originally fresh or brackish. The deposits formed by the lake "are largely composed of fine, friable, white calcareous marl, and this passes, on the one hand, into a cream-colored, partly oölitic sand, of calcareous and silicious grains, feebly cemented by calcite, and, on the other, into an impalpable clay charged with chloride of sodium and other soluble salts. All of these beds, excepting the most saline of the clays, are fossiliferous, affording, in great abundance, a few species of lacustrine gasteropoda." The area covered by these beds is completely circumscribed by the Bonneville beach. "Of the history of the beach, or, what is the same thing, of the history of the lake, we know only the last few pages. We know that the present low tide has been preceded by a high tide, the duration of which, though extended, was not unlimited, and we know that for a comparatively long antecedent period there had been no similar flood; but we do not know that there were or were not earlier floods; nor can we tell how low was the stage from which the water rose to its last maximum." The author thinks that the lake basin was filled by the melting of glaciers. As regards the water of Lake Bonneville, Mr. Gilbert seems to be in doubt whether it was fresh or salt, the evidence derived from both the fossils and the beds themselves being vague. The shells contained in the beds, he thinks, may have been borne into the lake by streams,

and there is an absence of any fresh-water mussels (*Unio*, etc.). "The salt," however, which is so prominent a characteristic of the present Sevier and Great Salt lakes, and abounds in all the later sediments of the shrunken ancient lake, is nearly absent from the beds most clearly associated with the upper beach; and its distribution indicates that Lake Bonneville, if not perfectly fresh, was at least far less saline than either Great Salt or Sevier Lake." Again, farther on, Mr. Gilbert inquires whether "the basin contains the amount of salt which would have sufficed to render the great lake briny. The ancient volume was no less than three hundred times greater than that of Great Salt Lake (when surveyed by Captain Stansbury), and the brine of the latter, so greatly diluted, would give only one thirteenth of one per cent. of salt. But if we add to the salt of Great Salt Lake that of Sevier Lake, and the far greater but indeterminate quantity accumulated in the sediments of the lower parts of the two deserts, we shall probably have enough to give Lake Bonneville, if it were undrained, the salinity of the ocean. In fine, we are led to believe that, while Lake Bonneville certainly held less salt than do its modern representatives, its recorded phenomena comprise no fact that places it definitely among either fresh or salt lakes." As bearing on the question whether the ancient Bonneville Lake was salt, brackish, or fresh, and whether the shells in the Bonneville beds lived in the waters of the lake itself and not alone in the tributary streams, we may cite the case of Lake Tanganyika, whose outlet has been discovered by Lieutenant Cameron. This explorer in his diary [1] in one place says, "Such an amount of water comes into the lake, and there are no signs of change of level, so that it seems impossible to dispose of all the surplus water by evaporation; besides which, so many streams run through salt soil that, if it were disposed of in that way, the lake would be as salt as brine." Again he says, "The whole country was at one time an enormous lake; . . . . of this sea, most probably a fresh-water one, Tanganyika, the Nyanzas, and the Livingstone lakes are probably the remains. It may have been salt, witness salt soil of Uvinza and Ugaga, and freshened by the continual rain-fall of thousands of years." Farther on he says, "The Lukuga *is* the outlet if any; it tastes the same as the Tanganyika, slightly salt (not salt, but peculiar), and *not* fresh, like the other rivers."

Have we not here a parallel between the present Lake Tan-

[1] Journal of the Royal Geographical Society, 1875, pp. 202, 210, 227.

ganyika on the African plateau, with its outlet the Congo, and the ancient Lake Bonneville, with its former outlet flowing either north or south or in both directions? Judging by the fossil shells so abundant in the Bonneville beds they must, it seems to us, have lived in the lake itself, for it is well known that brackish lakes and inlets support fresh-water molluscs and fish. Is it not probable that the ancient Great Salt Lake was once simply brackish, and that when, owing to the desiccation of the continent, its outlet or outlets dried up and the lake contracted, it became gradually saline?

As regards the supposed former outlet of Great Salt Lake, Mr. Gilbert supports the views of Professor Marsh and Bradley that the outlet was towards the north, into the Snake River Valley. Great Salt Lake was, Mr. Gilbert adds, but one of a group, as others must have filled the valleys of the Great Basin. "In the list of those which overflowed may probably be included all of the northern tier, bordering on the present drainage system of the Columbia River, and those which, lying at the feet of the Wahsatch range and the Sierra Nevada, received the streams from those mountains. What we know of the Death Valley and other southwesterly basins tends to show that they were not entirely filled.

"Of the interesting group of lakes that along the base of the Sierra Nevada survive the general desiccation, our route touched but one, and that the most southerly. Owen's Lake lies in a trough between the Sierra Nevada at the west, and the Inyo and Coso ranges at the east, and receives its water from Owen's River, which, rising seventy miles at the north, follows the trough and accumulates the streams from the adjacent mountains. It now contains a strong brine, and is without outlet, but it is surrounded by ancient beaches, and in the sands of the most elevated of these are abundant specimens of *Anodonta*, testifying to its former freshness. Its ancient area did not exceed its modern by more than one or two times, and the channel through which its surplus discharged is distinctly marked." — A. S. PACKARD, JR.

RECENT LITERATURE.

ORTON'S ANDES AND THE AMAZON.[1] — This is the work of a naturalist as well as a traveler, and presents a lively and, so far as we are aware, an entirely truthful account of the wonderful regions on each side of the Andes of Peru. Though the scientific results of the two expeditions across the Andes and down the Amazons have been published elsewhere, those of more popular interest are introduced into the narrative. The third edition contains much new matter, with a new map of the Marañon region, "a vast and interesting country, most rudely laid down on existing maps." The author also presents "facts illustrating the commercial resources and possibilities of the Valley of the Amazons, a subject which is destined to arrest the attention of enterprising men and nations." The present edition has been prepared by adding to the narrative of the expedition of 1867 a description of a more southerly route. The book is copiously and well illustrated, and describes a course of travel which will prove very attractive to tourists.

WILSON'S PREHISTORIC MAN.[2] — This standard book has passed into a third edition, in which "much of the original work has been rewritten. Several chapters have been replaced by new matter. Others have been condensed or recast, with considerable modifications and a new arrangement of the whole." The illustrations are abundant and excellent, a number of new ones having been engraved for this edition.

Commendation of such a work, so long and favorably known to the public, is scarcely necessary. A few points seem to us open to correction. For example, on page 34 (vol. i.) the author allows the following statement to appear: "Fossil human remains have also been recovered from a calcareous conglomerate of the coral reefs of Florida, estimated by Professor Agassiz to be not less than ten thousand years old." This estimate is worthless, as may be seen by a note in the NATURALIST (ii. 443) by Count Pourtales, the original discoverer of the bones. He says, "The human jaw and other bones found in Florida by myself in 1848 were not in a coral formation, but in a fresh-water sandstone on the shore of Lake Monroe, associated with fresh-water shells of species still living in the lake (*Paludina*, *Ampullaria*, etc.). No date can be assigned to the formation of that deposit, at least from present observation."

Professor Wilson is cautious in accepting the evidence of the high antiquity of man, rather more so than the majority of leading anthropologists.

[1] *The Andes and the Amazon; or, Across the Continent of South America.* By JAMES ORTON. Third Edition, revised and enlarged, containing Notes of a Second Journey across the Continent from Para to Lima and Lake Titicaca. With two Maps and numerous Illustrations. New York: Harper and Brothers. 1876. 12mo, pp. 645.

[2] *Prehistoric Man.* Researches into the Origin of Civilization in the Old and New World. By DANIEL WILSON. Third Edition, revised and enlarged. With Illustrations. In two volumes. London: Macmillan & Co. 1876. 8vo.

Recent Books and Pamphlets. — A Course of Practical Instruction in Elementary Biology. By T. H. Huxley, assisted by H. N. Martin. Second edition, revised. London and New York: Macmillan & Co. 1876. 12mo, pp. 279. $2.00.

Manual of the Vertebrates of the Northern United States, including the District east of the Mississippi River and North of North Carolina and Tennessee, exclusive of Marine Species. By David Starr Jordan. Chicago: Jansen, McClurg, & Co. 1876. 12mo, pp. 342. $2.00.

Report on the Geology of the Eastern Portion of the Uinta Mountains and a Region of Country adjacent thereto. With Atlas. By J. W. Powell. Washington. 1876. 4to, pp. 218.

Recherches sur les Phénomènes de la Digestion et sur la Structure de l'Appareil digestif chez les Myriapodes de Belgique. Par Félix Plateau. Bruxelles. 1876. 4to, pp. 94.

Note sur une Sécrétion propre aux Coléopteres Dytiscides. Par Félix Plateau. Bruxelles. 1876. 8vo, pp. 10.

Note sur les Phénomènes de la Digestion chez la Blatte américaine (*Periplaneta Americana* L.). Par Félix Plateau. Bruxelles. 1876. 8vo, pp. 30.

Proceedings of the Davenport Academy of Natural Sciences. Vol. i. 1867–1876. Davenport, Iowa. 8vo. pp. 294. With 36 Plates. $2.50.

Recent Explorations of Mounds near Davenport, Iowa. By R. J. Farquharson, M. D. (From the Proceedings of the American Association for the Advancement of Science, 1875.)

A List of Orthoptera collected by J. Duncan Putnam during the Summers of 1872–3–4 and 5, chiefly in Colorado, Utah, and Wyoming Territories. By Dr. Cyrus Thomas. (From the Proceedings of the Davenport Academy of Natural Sciences, vol. i.) Davenport, Iowa. June, 1876. 8vo, pp. 20.

Entomologischer Kalender für Deutschland, Oesterreich und die Schweiz auf das Jahr 1876. Herausgegeben von Dr. F. Katter. Putbus. 1876. 12mo, pp. 107.

On the Anatomy and Habits of *Nereis virens*. By F. M. Turnbull. (From the Transactions of the Connecticut Academy, vol. iii. August, 1876.) 8vo, pp. 15. With three Plates.

Rambles of a Naturalist in Egypt and other Countries. By J. H. Gurney. London: Jarrold and Sons. 12mo, pp. 307.

GENERAL NOTES.

BOTANY.[1]

Alfred W. Bennett on the Growth of the Flower-Stalk of the Hyacinth. — (Abstract of a paper read before the Linnean Society, London, March, 1876.) In a paper read to the society at its meeting on November 4, 1875, Mr. Bennett gave some details in respect of the remarkably rapid growth of the flower-stalk of the female flower of *Vallisneria spiralis*. The general results arrived at were that the greatest "energy of growth" was displayed by the apical portion of the peduncle or that immediately beneath the flower-bud, the energy apparently decreasing regularly towards the base of the flower-stalk. As this appeared to be opposed to the law stated by Sachs and others to govern the rate of growth of the different successive internodes of an aerial stem, he was anxious to ascertain how far it was in accord with the relative rapidity of growth of different portions of a single elongated

[1] Conducted by Prof. G. L. Goodale.

aerial internode. For this purpose he measured the growth of the common peduncle of the inflorescence of the hyacinth, with the following results in two specimens, one grown in a hyacinth-glass, the other in soil in a pot.

Specimen A, grown in a hyacinth-glass. This was first measured at noon on February 23d, when the peduncle, with a total length of 1.25 in., was divided into two equal portions of 0.625 in. At 10 A. M. on the 26th, when it had increased to 1.55 in., each of the two sections was again divided, the length of the four portions, proceeding from above downwards, being 0.35, 0.4, 0.4, and 0.4 in. Measurements were made twice and sometimes three times a day; and it was soon evident that the energy of growth of these different portions was very unequal. By ten P. M. on February 29th each of the three uppermost portions was still only 0.5 in. long, whilst the lowest had increased to 1.0 in. From this time the increased rapidity of growth of the lowest portion was still more marked. By ten P. M. on March 5th the lengths were respectively 0.9, 0.9, 0.85, and 2.35 in., and at ten P. M. on March 11th, when the growth had finally ceased, the measurements were 1.15, 1.0, 1.0, and 3.45 in., making a total of 6.6 in. The following is a complete table of the measurements: —

	A.	B.	C.	D.	Total.	Increase.
Feb. 26th, 10 A. M.	.35	.4	.4	.4	1.55	..
12 noon	.35	.4	.4	.45	1.6	.05
10 P. M.	.35	.4	.4	.5	1.65	.05
27th, 1 P. M.	.4	.4	.4	.55	1.75	.1
10 P. M.	.4	.4	.4	.55	1.75	.0
28th, 10 A. M.	.45	.4	.4	.65	1.9	.15
3 P. M.	.45	.4	.4	.7	1.95	.05
10 P. M.	.45	.45	.4	.75	2.05	.1
29th, 10 A. M.	.5	.45	.45	.8	2.2	.15
3 P. M.	.5	.5	.45	.95	2.4	.2
10 P. M.	.5	.5	.5	1.0	2.5	.1
March 1st, 10 A. M.	.55	.55	.5	1.2	2.8	.3
10 P. M.	.6	.55	.5	1.25	2.9	.1
2d, 10 A. M.	.65	.6	.55	1.3	3.1	.2
6 P. M.	.7	.65	.55	1.35	3.25	.15
3d, 10 A. M.	.75	.65	.6	1.5	3.5	.25
3 P. M.	.75	.7	.6	1.7	3.75	.25
10 P. M.	.8	.7	.6	1.9	4.0	.25
4th, 10 A. M.	.8	.75	.75	2.2	4.5	5
10 P. M.	.85	.8	.8	2.3	4.75	.25
5th, 10 A. M.	.85	.8	.8	2.3	4.75	.0
10 P. M.	.9	.9	.85	2.35	5.0	.25
6th, 10 A. M.	.95	.9	.9	2.5	5.25	.25
10 P. M.	1.0	.9	.9	2.7	5.5	.25
7th, 10 A. M.	1.0	.9	.9	2.75	5.55	.05
10 P. M.	1.0	.9	.95	2.9	5.75	.2
8th, 10 A. M.	1.05	.9	1.0	3.0	6.0	.25
10 P. M.	1.1	1.0	1.0	3.15	6.25	.25
9th, 10 A. M.	1.1	1.0	1.0	3.2	6.3	.05
11 P. M.	1.15	1.0	1.0	3.25	6.4	.1
10th, 10 A. M.	1.15	1.0	1.0	3.4	6.55	.15
10 P. M.	1.15	1.0	1.0	3.45	6.6	.05
11th, 10 A. M.	1.15	1.0	1.0	3.45	6.6	.0

It will be seen from the above table that by far the greatest total energy of growth was displayed by the lowest of the four segments, which increased during the twelve days between February 26th and March 10th from 0.4 to 3.45 in., or 762.5 per cent. of its original length. The next greatest energy, but at a great interval, was exhibited by the apical section, which increased from 0.35 to 1.15, or 228 per cent., while the two central portions exhibited the least activity, increasing only from 0.4 to 1.0, or 150 per cent. of their original length.

Specimen B, grown in a pot. In the second example, the evidence was still more conclusive that the growth of the peduncle is mainly basilar. On February 26th, the flower-stalk, then an inch in length, was divided into two equal portions of 0.5 in. On the next day, when it had increased to 1.1 in., the lowest zone of 0.1 in. was marked off separately. By ten P. M. on February 29th this lowest zone (C+D) had increased to 0.7 in., or by 600 per cent. of its original length, while the two uppermost zones were still respectively only 0.55 and 0.5 in. long. The lowest zone was then again divided into two portions, the upper one being 0.5 and the lower 0.2 in. long. By ten P. M. on March 3d the lengths of the four zones, commencing from the top, were 0.8, 0.8, 0.75, and 0.75 in., giving a total of 3.1 in. At ten P. M. on the 7th, the total length of 6.5 in. was distributed thus: 1.6, 1.5, 1.25, and 2.15 in.; and at ten A. M. on the 13th, when the final length of 8.2 inches had been attained, the measurements were respectively 2.2, 1.75, 1.5, and 2.75 in. The following is the complete table: —

	A.	B.	C.	D.	Total.	Increase.
Feb. 26th, 9 A. M.	.5	.5	..	..	1.0	..
10 P. M.	.5	.5	..	..	1.0	.0
27th, 1 P. M.	.5	.55	..	..	1.05	.05
10 P. M.	.5	.5	.1	..	1.1	.05
28th, 9 A. M.	.5	.5	.2	..	1.2	.1
3 P. M.	.5	.5	.2	..	1.2	.0
10 P. M.	.5	.5	.2	..	1.2	.0
29th, 9 A. M.	.55	.5	.45	..	1.5	.3
10 P. M.	.55	.5	.5	.2	1.75	.25
March 1st, 10 A. M.	.55	.55	.5	.3	1.9	.15
10 P. M.	.6	.55	.55	.3	2.0	.1
2d, 9 A. M.	.6	.6	.55	.4	2.15	.15
6 P. M.	.65	.6	.55	.5	2 3	.15
3d, 10 A. M.	.65	.65	.65	.6	2.55	.25
3 P. M.	.75	.75	.65	.65	2.8	.25
10 P. M.	.8	.8	.75	.75	3.1	.3
4th, 10 A. M.	.9	.9	.8	1.1	3.7	.6
10 P. M.	.9	.9	.85	1.25	3.9	.2
5th, 10 A. M.	1.0	1.0	1.0	1.25	4.25	.35
10 P. M.	1.05	1.1	1.1	1.25	4.5	.25
6th, 10 A. M.	1.2	1.25	1.1	1.55	5.1	.6
10 P. M.	1.35	1.3	1.2	1.75	5.6	.5
7th, 10 A. M.	1.5	1.5	1.25	1.85	6.1	.5
10 P. M.	1.6	1.5	1.25	2.15	6.5	.4
8th, 10 A. M.	1.65	1.5	1.25	2.15	6.55	.05
10 P. M.	1.7	1.55	1.35	2.15	6.75	.2

	A.	B.	C.	D.	Total.	Increase.
9th, 10 A. M.	1.85	1.6	1.4	2.15	7.0	.25
11 P. M.	2.0	1.65	1.4	2.35	7.4	.4
10th, 10 A. M.	2.0	1.65	1.4	2.45	7.5	.1
10 P. M.	2.0	1.65	1.4	2.45	7.5	.0
11th, 10 A. M.	2.0	1.65	1.45	2.55	7.65	.15
12th, 10 A. M.	2.15	1.7	1.5	2.75	8.1	.45
10 P. M.	2.15	1.7	1.5	2.75	8.1	.0
13th, 10 A. M.	2.2	1.75	1.5	2.75	8.2	.1
10 P. M.	2.2	1.75	1.5	2.75	8.2	.0

Starting from the measurement at ten P. M. on February 27th, the lowest of the three zones, which then measured 0.1 in., had increased by March 13th so as to make up the two zones C and D together 4.25 in., or 4150 per cent. of its original length, while the remainder had only increased from 1.0 to 3.95, or at the rate of 295 per cent. Again, starting from ten P. M. on March 29th, when the four zones were first marked off, the ultimate increase of the lowest was from 0.2 to 2.75 in., or 1275 per cent.; the next greatest energy was displayed by the uppermost, which increased from 0.55 to 2.2, or just 300 per cent.; next came the second zone from the top, which showed an increase from 0.5 to 1.75, or 250 per cent.; and finally the third from the top, showing an increase from 0.5 to 1.5 in., or exactly 200 per cent. The rate of growth was again subject to great irregularities, which were no doubt attributable mainly to changes in temperature. Making the division between day and night as before at ten A. M. and ten P. M., the total amount of growth was again not very different in the two; but instead of being, as in the previous case, slightly in favor of the day, was rather more decidedly in favor of the night; of the 6.5 in. growth from February 29th to March 13th, 3 inches was by day, and 3.5 inches by night.

It will therefore be seen that, as far as these observations on the relative growth of different portions of the same internode go, they are entirely in accord with the statement of Professor Sachs, in regard to that of different internodes on the same branch, that the maximum energy of growth is exhibited at a period considerably below the *punctum vegetationis*, though it is here much nearer the base than in the cases measured by Sachs. This brings out into still stronger relief the opposite phenomenon displayed by the elongated submerged flower-stalk of *Vallisneria*, the energy of growth of which is manifested mainly in the apical portion. The elongation of the peduncle of the hyacinth continues considerably after the complete expansion of the flowers, until the lowest in the raceme begin to fade.

These observations differ in several points from those on the flower-stalk of the hyacinth recorded by Münter in the *Botanische Zeitung* for February 24, 1843. He describes its growth as not centrifugal, like that of most flower-stalks, but centripetal; that is, it ceases to grow first near the flower and finally at the base. It will be seen that Mr. Bennett's two experiments agree in this, that while the energy of growth

is greatest in the basal portion, the apical portion continues to grow for very nearly or quite as long. The growth of the flower-stalk of *Pelargonium* he describes, on the other hand, as centrifugal, the growth of each zone ceasing before the one next above it.

With regard to the relative amount of growth by day and by night, Münter also gives no measurements, but states that in the daytime the plant grows at first five times, then four times, and then three times stronger than by night. This differs materially from the general law as stated by Sachs (Text-Book, English edition, page 749), that "the plant will, according to circumstances, sometimes grow more quickly by day, sometimes by night, without exhibiting any exactly recurrent periodicity," the difference, however, being never so great as that stated by Münter. Mr. Bennett's observations are more in accordance with this.

BOTANICAL PAPERS IN RECENT PERIODICALS.— *Comptes rendus*, No. 4. Trécul, Theory of Metamorphosis of Branches for Diverse Functions. Decaisne, Note on *Cedrela Sinensis.* Henneguy, On Reproduction in Volvox. No. 5. Trécul, On *Mentzelia.* J. Joubert and Chamberland, On Fermentation in Fruits kept in Carbonic Acid. Durin, On Cellulosic Fermentation. Béchamp, On the Microzymas of Germinating Barley and of Sweet Almonds, as producing Diastase and Synaptase. No. 6. Renault, On *Neuropteris.*

Flora, No. 22. Weiss, On the Relations of Growth, and the Course of Fibro-Vascular Bundles in *Piperaceæ.* (Continued also in Nos. 23 and 25.) No. 23. De Thümen, Fungi of South Africa. Nylander, On Certain Lichens in Mr. Wright's Cuban Collection (40 new species). No. 24. Dr. Christ, of Basel, Varieties of *Rosa.* Geheeb, Notes on Mosses.

Botanische Zeitung, No. 35. H. Hoffmann, Experiments in the Cultivation of Varieties. (Continued in No. 36.) V. Vesque-Püttlingen, On the Periodicity of the Currents in Protoplasma.

ZOÖLOGY.

THE PILOT FISH.— Eleven years ago, while on a voyage from India to this country, we were beset by many calms while crossing the "line." On one of these occasions, while some of the passengers were amusing themselves looking over the stern of the vessel, two beautiful pilot fishes (Naucrates?) were seen, and soon after a portion of an unusually large shark. Immediately a hook baited with salt pork was thrown overboard. When it touched the water these pilot fishes were seen to approach it, and then suddenly dart under the vessel. Soon a very large shark appeared and received the bait. As soon as safely secured the sailors drew him on deck. When a suitable opportunity was given for examining him, these two pilot fishes were seen attached to the body. At what particular portion they attached themselves I am unable to state. They were removed and placed in a bucket of salt water, where they swam about as if nothing had happened.— A. H. BURNELL.

A Spider Fisherman. — Just before the late war I was at Col. Oakley Bynum's spring, in Lawrence County, Ala., near the town of Courtland, where I saw a school of minnows playing in the sunshine near the edge of the water. All at once a spider as large as the end of my finger dropped down among them from a tree hanging over the spring. The spider seized one of the minnows near the head. The fish thus seized was about three inches long. As soon as it was seized by its captor it swam round swiftly in the water, and frequently dived to the bottom, yet the spider held on to it. Finally it came to the top, turned upon its back and died. It seemed to have been bitten or wounded on the back of the neck near where the head joins. When the fish was dead the spider moved off with it to the shore. The limb of the tree from which the spider must have fallen was between ten and fifteen feet above the water. Its success shows that it had the judgment of a practical engineer. — T. M. Peters. (Communicated by the Smithsonian Institution.)

The Nature of Monads. — We have additional discoveries regarding the nature of monads by the Russian naturalist, Cienkowski. These organisms are on the border land of the plant world, and in some cases form protoplasmic nets (plasmodia) like the plant *Myxomycetes*. These plasmodia have the function of falling apart into amœba-like forms, which have hitherto been regarded as independent animal organisms; hence he thinks that many Amœbæ do not represent independent forms, but belong to the developmental cycle of other and plant-like organisms. Among the monads, Cienkowski, according to a German correspondent of *Nature*, has observed forms in various stages of encystment, self-division, and formation of colonies. But the most remarkable series of changes were observed in *Diplophrys stercorea*, an extremely small cell-like organism with a yellow spot and pseudopodia at two opposite ends of the body. These little bodies, observed in moist horse-dung, multiply by division, and form by union of the pseudopodia long strings in which separate individuals can glide to and fro. "Thus the boundary lines which it has so long been usual to draw between plant and animal organisms, and between the individual groups of those lowest forms of life, appear more and more illusory, and the supposition is recommended of a common lowest kingdom of organisms, that of Protista (Haeckel), out of which animals and plants have by degrees been differentiated."

Mayer's Ontogeny and Phylogeny of Insects.[1] — "Ontogeny" is a term devised by Haeckel, and means the development or embryonic and post-embryonic changes of the individual; "phylogeny" corresponds to its English equivalent, "ancestry," while the present essay is an attempt to explain the origin and ancestry of the six-footed insects (Hexapoda) from embryological and anatomical data. No new facts, so far as

[1] Ueber Ontogenie und Phylogenie der Insekten. Eine akademische Preisschrift. Von Dr. Paul Mayer, in Jena. Jenaische Zeitschrift für Naturwissenschaft. x. heft 2. Jena. 1876. With four plates, pp. 125–221.

we are aware, are presented by the author, whose essay has, apparently, contrary to usage in German universities, been crowned not for the original work it contains but for the ideas suggested by the labors of preceding authors.

In trying to reconstruct the form of the primitive insect, Mayer insists that it should be done from a study of the winged adult or *imago*, "since *a priori* we cannot know how far the form of the larva is original or secondary." Other authors have with better reasons derived the ancestral form from the larva.

Mayer's ancestral insect, then, which he calls *Protentomon*, had a body divided into a head, thorax, and abdomen, the latter consisting of eleven segments, while there were six thoracic feet with five-jointed tarsi, and two pairs of wings, nine (and perhaps eleven) pairs of stigmata, a pair of salivary glands, and four excretory organs or Malpighian vessels, besides a well-developed nervous system, heart, and an aaorta, as usual in existing insects.

This hypothetical *Protentomon* is derived by Mayer from the worms,[1] in opposition to the suggestions of Fritz Müller and Brauer that the insects originated from the Crustacea. This worm (1), the parent of the half a million species of insects which have peopled the globe during the present and past ages, was "an unjointed worm, a common starting-point for the Tracheata and higher worms, and also a near relation of the ancestral form of the Crustacea." This worm then (2) transformed into a higher organism, with eighteen joints to its body and at least fourteen pairs of segmental organs, with perhaps also a masticatory apparatus in the form of jaws; and was perhaps nearly related to the existing Annelids. (3.) A third step towards the insects was a form similar to the second, but with ventral and perhaps also dorsal appendages on all the segments; it was still aquatic. It transformed (4) into a worm with tracheæ and with dissimilar segments (the appendages in part beginning to disappear). It lived in fresh water. and is called by our author *Prototracheas*. (5.) This *Prototracheas* became an *Archentomon*, still aquatic, with six feet, and clearly defined head, thorax, and abdomen. Finally this fifth form acquired two pairs of wings, was terrestrial in its habits, and became (6) a *Protentomon*.

The author then discusses the ancestry of the different orders of insects. It is noticeable that in treating of them he begins with the Hymenoptera and ends with the Neuroptera, following in fact, unconsciously, the reviewer's classification proposed in 1863. The Linnæan Neuroptera are, however, broken up into several orders, the author following the usual German system; but Mayer is the first German author, so far as we are aware, who places the Hymenoptera at the head of

[1] This view was advocated by the writer (though Mayer does not mention it) in Our Common Insects, chapter xiii., entitled Ancestry of Insects (1873). This is the more inexcusable since Dr. Mayer quotes from the essay.

the insects, and the Coleoptera in the neighborhood of the Hemiptera and Orthoptera, where they unquestionably belong.

Mayer adopts the suggestions of Bütschli and Semper that the air-tubes of insects originated from the segmental organs of worms, and, discarding Gegenbaur's view that the air-tubes were at first internal, closed air-sacs, he believes that the stigmata or breathing holes were the first to be formed. It may be objected that as insects are already provided with renal vessels, it is not necessary to suppose that segmental organs (also in part excretory) survived in them, and the inquiry arises whether the air-tubes of insects may not have arisen from the water-vascular system of the lower worms, which communicates with two or more external openings. In framing hypotheses like these, one guess may be as good as another.

The author, in a foot-note, combats with considerable unction our suggestion, made in 1867, that the head of insects consisted of seven segments. It may be observed that at that time we were influenced by the prevailing views of Agassiz, Dana, and others, who regarded the ocelli and eyes as homologues of the limbs. This view was corrected in the Memoirs of the Peabody Academy of Science, ii. 21, 1871 (a work from which our author quotes), and also in several other places, including the Guide to the Study of Insects, third edition, 1872; and the view that the normal number of cephalic segments is four was at the same time and in the same places insisted upon.

Dr. Mayer also quotes us as believing that the parts of the ovipositor are not homologous with the legs, a view we suggested in 1866, but after fresh embryological studies retracted in the above-mentioned Memoir in 1871 (which the author seems to have read), and also in other places, notably the essay on the Ancestry of Insects, quoted by Mayer, where the view that the ovipositor of the Hymenoptera, Hemiptera (Cicada), and Orthoptera, as well as the spring of the Thysanura and the spinnerets of spiders, are homologues of the legs is emphasized.

As regards the position of the primitive band of insects, Mayer ignores the remarks of Dr. Dohrn on its significance in classification, and considers that the circumstance whether the primitive band is external or floats within the yolk, is of much importance, laying down the law that "insects with an external primitive streak are in general older than those with an inner." We have previously[1] objected to Dohrn's classification of insects into "ectoblasts" and "entoblasts," and would make a similar objection to Mayer's views, since in weevils (*Attelabus*), abundantly proved by Dr. Le Conte to be the oldest of Coleoptera (a fact ignored by Dr. Mayer, whose genealogical tree of Coleoptera represents the antiquated classification of this order), we demonstrated that the primitive band is external, while in *Telephorus* it is internal, though our

[1] Embryological Studies on Hexapodous Insects. Memoirs of the Peabody Academy of Science, 1872, p. 15.

observations are called in question by Dr. Mayer, who, however, so far as we know, has never published any observations on the embryology of this or any other animal, the entire essay being based on facts observed by previous writers.

While the essay is interesting and suggestive, the leading idea that hexapodous insects first appeared as winged organisms and not as larval forms, will, we think, be found to have no valid foundation. We should with as much reason derive the acalephs from an ancestral free-swimming medusa, and not from a hydra-like form, or the Amphibia from the tailless rather than the tailed forms, views with which we imagine few zoölogists would agree. — A. S. PACKARD, JR.

ANTHROPOLOGY.

ABORIGINAL (?) GUN-FLINTS. — Among the ancient ruined buildings of Utah and Arizona I picked up two curious objects of stone, the use of which I for some time was unable to determine. At first I supposed them to have been arrow-points or scrapers which had been broken at the points, leaving the square buts, but on careful examination I found that they had each been laboriously chipped on the four edges, and from their general appearance had undoubtedly been used as gun-flints. In order to satisfy myself on this point, I procured a large number of modern flints made by the whites, and on comparison I found that the two from the West resembled them closely in size and shape, only differing in material and in the manner in which they had been flaked. They are from one eighth to one fourth of an inch in thickness, number one being thickest at the lower or striking edge and number two at the upper. The material of number one (by far the finer specimen) is a light gray flint with white and pink water markings. That of number two is a pink agate sprinkled with specks and blotches of red moss. Both of these varieties of stone are found throughout the West, and objects manufactured from them are numerous amongst the ruins. They are not to be found, except in rare cases, if at all, in the eastern portion of the United States, and we may therefore reasonably suppose that the flints were made on the Pacific slope. That such objects of a civilized people should occur among the rude implements of an aboriginal and prehistoric race is somewhat surprising, especially when it has heretofore been supposed that this particular section has not been traversed by whites until the past few years, when the flint-lock has been superseded by the percussion cap. This fact, however, cannot be vouched for, and although we know that no official expeditions have passed over this country, it is possible that hunters or wandering scouts may have visited the ruins of the San Juan Valley. The district in which I found the flints has not been occupied by tribes of Indians for many years, as it is a barren, dry desert, devoid of water (with the exception of the warm San Juan) and almost destitute of grass and wood. It is, indeed, a matter of doubt whether it has been inhabited since the disappearance of the Pueblo race which built and occupied the old houses which have been

lying in ruins for centuries. The fact that these objects were discovered among arrow-heads, pottery, and implements of undoubted antiquity, associated with no objects of modern date, would point to an ancient origin. The flint-lock, however, did not come into use until the middle of the seventeenth century, having originated in France about the year 1635. They could not, therefore, have been dropped by the Spaniards, who traveled through Arizona and New Mexico in the early part of the *sixteenth* century. The match-lock was employed by them in their conquests through Mexico and the north, even after the wheel-lock had been invented in Italy.

The two specimens possess all the appearance of having been fashioned by the aborigines in their peculiar manner. It is not impossible that they may have been made by Indians under the direction of European hunters or explorers, and, on the other hand, they may have been manufactured by whites. The nomadic tribes of the Southwest must have procured arms from the adventurous pioneers as early as the middle of the eighteenth century, and flints must necessarily have been made by the savages as the first ones were lost or broken. Since the flint-lock has been out of use for many years, it is highly probable that the two objects herein described were dropped where they were found, as early as the latter part of the last century or during the first few years of this. They are particularly interesting, however, as showing that the valley of the San Juan River has in all probability been traversed by whites, possibly a century or more ago. It is also possible that the flints may have been brought to that section by Indians from a distant locality; but the first supposition seems to me the most reasonable. — EDWIN A. BARBER.

ANTHROPOLOGICAL NEWS. — Twenty-eight pages of Nos. 1 and 2 of the *Mittheilungen der anthropologischen Gesellschaft in Wien* are taken up with a discussion by Ferd. Freiherrn von Adrian upon the influence of vertical position on the earth's surface upon human settlements. The article is rendered exceedingly valuable by abundant bibliographical references. In *Revue Scientifique* for July 15th, M. Paul Bert handles a kindred topic in a contribution entitled "La Pression de l'Air et les Êtres vivants. In the same number of the review, Turkish manners in 1650 are discussed by a "traveler from Algeria."

Some light is thrown upon prehistoric batons, so called, by a pamphlet published in Lyons by M. F. Chabas, and entitled Sur l'Usage des Bâtons de Main chez les Hébreux et dans l'ancienne Égypte. One of the best features in the treatise is the collation of authorities.

M. Émile Guimet has edited in the same form from the Lyons press a tract by M. Chabas upon the time of the Exodus. From numerous parallelisms between the Jewish Scriptures and the papyri the learned author concludes to place the Exodus in the reign of Menephta I., the successor of Rameses II., of the XIXth dynasty. The paper was first read before the Academy of Science, Belles-Lettres, and Art of Lyons, April 27, 1875.

The contents of Nos. 6 and 7 of *Matériaux* are very nicely distributed over the countries of Europe in which archæological investigations are in progress. Vladimir de Mainoff contributes an article upon the Kourganes (tumuli) of Little Russia. These structures are the burial-mounds of the Severianes, in the transition period between the bronze and the iron age. Some of them contain burials by inhumation, others by incineration. In each of the two kinds of Kourganes there is a gradation of the form of interment.

Scandinavia has an unusual share of space devoted to the following themes: the State Museum of History, the history of Swedish archæological researches; the age of bronze in Northern Sweden; the antiquities of Bohnslaen, and, finally, three very instructive sketches upon Finnish antiquities and history.

With reference to France, we have a continuation of the discussion between Abbé Maillard and M. Mortillet upon the stratigraphical relation between the Solutrian and the Moustierian Age, an account of prehistoric monuments in different districts of France, and a very valuable table of the number of stations, grottoes, and dolmens in each of the departments.

The review of Italy embraces papers relative to archæological matters purely. The only article relative to extra-European matters is an account of a prehistoric atelier at Hassi-el M' Kaddem, eight kilometres from the oases of Ouargla. Among the articles discovered were arrow-heads, beads, and pottery.

Richard Andree contributes to the Austrian *Mittheilungen* for February, 1876, an article upon lucky days, lucky meetings, and augury in the history of culture.

We have in the first quarterly part of the *Archiv für Anthropologie* the usual array of valuable matter. Dr. Schmidt, of Essen, gives us a paper upon the leveling of the skull. After examining the various plans and instruments which have been devised, the author concludes that the level which brings the beginning of the zygomatic arches over the opening of the ear in a line with the lower edge of the orbital cavity, adopted at a general meeting of the Göttingen society, is the best horizontal, coming the nearest to the true physiological horizontal, and having, of all the normals, the greatest stability. Professor A. Eclar contributes an article upon the influence of cranial deformation on the volume, position, and shape of the brain and of its separate parts. The name of this author is sufficient to render his work authoritative upon this vexed question. Professor Japetus Steenstrup reviews the question, "Have we found in the interglacial strata of Switzerland veritable traces of human beings or only the work of beavers?" Wood-cuts of sticks gnawed by modern rodents for food and for use are given. Shorter articles occur upon the quaternary fauna in the valley of the Donau, upon prehistoric and culture-historical terminology, upon the natives of

New Guinea and the neighboring islands, upon the Wetzikon sticks, and upon recent anthropological works which have appeared.

Professor Paolo Mantegazza contributes to *Archivio* a sixteen-page article upon the expressions of grief.

The subsection of anthropology was organized by the American Association at Buffalo, with Lewis H. Morgan as chairman and Otis T. Mason as secretary. Professor Morse, in his address before Section B, alluded to the eminent labors of Morton, Wyman, and others in special fields, and the list might be multiplied by adding the names of many living and dead, who, in America, have added materially to the progress of anthropology. The aim of the subsection of the American Association is to bring the authors of these researches together, and to make them better acquainted. It is earnestly hoped that the meeting to be held next year at Nashville will be crowded with anthropologists, specialists in the various fields of descriptive and deductive anthropology of extinct and extant races, in every part of its three divisions, of man, environment, and culture. — O. T. MASON.

GEOLOGY AND PALÆONTOLOGY.

PALÆONTOLOGY AND THE DOCTRINE OF DESCENT. — In an essay on the Pliocene fresh-water shells of Southern Austria, by Dr. Neumayr and Herr Paul, the authors describe numerous modifications of the genus *Vivipara* or *Paludina*, which occur in prodigious abundance throughout the whole series of fresh-water strata. Of this genus there are forty distinct *forms* (Dr. Neumayr very properly hesitates to call them all *species*) which are named and described in this monograph, and between which, as the authors show, so many connecting links, clearly illustrating the mode of derivation of the newer from the older types, have been detected. The authors, remarks Mr. J. W. Judd in *Nature*, have demonstrated that the species with highly complicated ornamentation were variously derived by descent — the lines of which are in most cases perfectly clear and obvious — from the simple and unornamented *Vivipara achatinoides* of the Congerien-schichten, which underlies the Paludina beds. Some of these forms have been regarded as types of a distinct genus (*Tulotoma*) by Sanberger. "And hence we are led to the conclusion that a vast number of forms, certainly exhibiting specific distinctions, and, according to some naturalists, differences even entitled to be regarded as of generic value, have all a common ancestry."

ICE-MARKS IN NEWFOUNDLAND. — In the second part of his article on Ice and Ice Work in Newfoundland, in the *Geological Magazine*, Professor J. Milne says that "the island itself, its principal bays, its mountains, its lakes and rivers, its lines of igneous protrusions, its ice-grooves and scratches, and the general strike of the rocks, which, as was shown by Jukes, may in part account for the tendencies of the other features, have all been shown to trend from about 27° east of north to

27° west of south." He believes that the ice-marks were made by glaciers rather than by floating ice (though there are still a few lingering supporters of the iceberg theory), thus substantiating, by the results of two summers' travels in Newfoundland, the observations made by the undersigned during two summers' travels along the coast of Labrador.— A. S. PACKARD, JR.

GEOGRAPHY AND EXPLORATION.

EXTRACTS FROM STANLEY'S LAST LETTERS FROM CENTRAL AFRICA. — From one of the many spurs of Kabuga we obtained a passing glimpse of the king of mountains, Gambaragara, which attains an altitude of between thirteen thousand and fifteen thousand feet above the ocean. Snow is frequently seen, though not perpetual. On its summits dwell the chief medicine men of Kabba Rega, a people of European complexion.

Some half-dozen of these people I have seen, and at sight of them I was reminded of what Mukamba, king of Uzige, told Livingstone and myself respecting white people who live far north of his country. They are a handsome race, and some of the women are singularly beautiful. Their hair is kinky, but inclined to brown in color. Their features are regular, lips thin, but their noses, though well-shaped, are somewhat thick at the point. Several of their descendants are scattered throughout Unyoro, Ankori, and Ruanda, and the royal family of the latter powerful country are distinguished, I am told, by their pale complexions. The queen of Sasua Islands, in the Victoria Nyanza, is a descendant of this tribe.

Whence came this singular people I have had no means of ascertaining except from the Waganda, who say that the first king of Unyoro gave them the land around the base of Gambaragara Mountain, wherein through many vicissitudes they have continued to reside for centuries. On the approach of an invading host they retreat to the summit of the mountain, the intense cold of which defies the most determined of their enemies.

The geographical knowledge we have been able to acquire by our forcible push to the Albert Nyanza is considerable. The lay of the plateau separating the great reservoirs of the Nile, the Victoria and Albert Nyanzas, the structure of the mountains and ridges, and the course of the water-sheds, and the course of the rivers Katonga and Rusango have been revealed. The great mountain Gambaragara and its singular people have been discovered, besides a portion of a gulf of the Albert, which I have taken the liberty to call, in honor of her Royal Highness Princess Beatrice, Beatrice Gulf.

This gulf, almost a lake by itself, is formed by the promontory of Usongora, which runs southwest some thirty miles from a point ten geographical miles north of Unyampaka. The eastern coast of the gulf is

formed by the countries of Irangara, Unyampaka, Buhuju, and Mpo-oro, which coast line runs a nearly south-southwest course. Between Mpororo and Usongora extend the islands of the maritime state of Utumbi. West of Usongora is Ukonju, on the western coast of Lake Albert, reputed to be peopled by cannibals. North of Ukonju is the great country of Ulegga.

Coming to the eastern coast of Lake Albert we have Ruanda running from Mpororo on the east to Ukonju on the west, occupying the whole of the south and southeast coast of Lake Albert. North of Unyampaka, on the east side, is Irangara, and north of Irangara the district of Toro. Unyoro occupies the whole of the east side from the Murchison Falls of the Victoria Nile to Mpororo, for Unyampaka, Toro, Buhuju, and Irangara are merely districts of Unyoro. The great promontory of Usongora, which half shuts in Beatrice Gulf, is tributary to Kabba Rega, though governed by Nyika, king of Gambaragara.

Usongora is the great salt field whence all the surrounding countries obtain their salt. It is, from all accounts, a very land of wonders, but the traveler desirous of exploring it should have a thousand Sniders to protect him, for the natives, like those of Ankori, care for nothing but milk and goatskins. Among the wonders credited to it are a mountain emitting "fire and stones," a salt lake of considerable extent, several hills of rock salt, a large plain encrusted thickly with salt and alkali, a breed of very large dogs of extraordinary ferocity, and a race of such long-legged natives that ordinary mortals regard them with surprise and awe.

After circumnavigating Lake Windermere we entered the Kagera River, and almost immediately it flashed on my mind that I had made another grand discovery, — that I had discovered, in fact, the true parent of the Victoria Nile.

If you glance at Speke's map you will perceive that he calls this river the Kitangule River, and that he has two tributaries running to it called respectively the Luchuro and the Ingezi. Speke, so wonderfully correct, with a mind which grasped geographical knowledge with great acuteness and arranged the details with clever precision and accuracy, is seriously in error in calling this noble river Kitangule. Neither Waganda nor Wanyamba know it by that name, but they all know the Kagera River, which flows near Kitangule. From its mouth to Urundi it is known by the natives on both banks as the Kagera River. The Luchuro, or rather Lukaro, means "higher up," but is no name of any river. Of the Ingezi I shall have occasion to speak further on.

While exploring the Victoria Lake I ascended a few miles up the Kagera, and was then struck with its great volume and depth, so much so as to rank it as the principal affluent of the Victoria Lake. But in coming south, and crossing it at Kitangule, I sounded it and found fourteen fathoms of water, or eighty-four feet deep, and one hundred and

twenty yards wide. This fact, added to the determined opinion of the natives that the Kagera was an arm of the Albert Nyanza, caused me to think the river worth exploring. I knew, as all know who know anything of African geography, that the Kagera could not be an effluent of Lake Albert, but their repeated statements to that effect caused me to suspect that such a great body of water could not be created by the drainage of Ruanda and Karagwe; that it ought to have its source much farther, or from some lake situate between lakes Albert and Tanganyika.

When I explored Lake Windermere I discovered, by sounding, that it had an average depth of forty feet, and that it was fed and drained by the Kagera. On entering the Kagera I stated that it flashed on my mind that the Kagera was the real parent of the Victoria Nile; by sounding I found fifty-two feet of water in a river fifty yards wide. I proceeded on my voyage three days up the river, and came to another lake about nine miles long and a mile in width, situate on the right hand of the stream. At the southern end of the lake, and after working our way through two miles of papyrus, we came to the island of Unyamubi, a mile and a half in length.

Ascending the highest point on the island the secret of the Ingezi or Kagera was revealed. Standing in the middle of the island I perceived it was about three miles from the coast of Karagwe and three miles from the coast of Kishakka, west, so that the width of the Ingezi at this point was about six miles, and north it stretched away broader, and beyond the horizon green papyri mixed with broad gray gleams of water. I discovered, after further exploration, that the expanses of papyri floated over a depth of from nine to fourteen feet of water; that the papyri, in fact, covered a large portion of a long, shallow lake; that the river, though apparently a mere swift-flowing body of water, confined apparently within proper banks by dense, tall fields of papyri, was a mere current, and that underneath the papyri it supplied a lake, varying from five to fourteen miles in width and about eighty geographical miles in length.

Descending the Kagera again, some five miles from Unyamubi the boat entered a large lake on the left side, which, when explored, proved to be thirteen geographical miles in length by eight in breadth.

From its extreme western side to the mainland of Karagwe east was fourteen miles, eight of which was clear, open water; the other six were covered by floating fields of papyri, large masses or islands of which drift to and fro daily. By following this lake to its southern extremity I penetrated between Ruanda and Kishakka. I attempted to land in Ruanda, but was driven back to the boat by war-cries, which the natives sounded shrill and loud.

Throughout the entire length (eighty miles) the Kagera maintains almost the same volume and almost the same width, discharging its sur-

plus waters to the right and to the left as it flows on, feeding, by means of the underground channels, what might be called by an observer on land seventeen separate lakes, but which are in reality one lake, connected together underneath the fields of papyri, and by lagoon-like channels meandering tortuously enough between detached fields of the most prolific reed. The open expanses of water are called by the natives so many "rwerus" or lakes; the lagoons connecting them and the reed-covered water are known by the name of "Ingezi." What Speke has styled Lake Windermere is one of these rwerus, and is nine miles in extreme length and from one to three miles in width. By boiling point I ascertained it to be at an altitude of 3760 feet above the ocean and about 320 feet above Lake Victoria. The extreme north point of this singular lake is north by east from Uhimba south, its extreme southern point. Karagwe occupies the whole of its eastern side. Southwest it is bounded by Kishakka, west by Muvari, in Ruanda, northwest by Mpororo, and northeast by Ankori. At the point where Ankori faces Karagwe, the lake contracts, becomes a tumultuous, noisy river, creates whirlpools, and dashes itself madly into foam and spray against opposing rocks, and finally rolls over a wall of rock ten or twelve feet deep with a tremendous uproar, for which the natives call it Morongo, or the Noisy Falls.

Since I left Zanzibar I have traveled 720 miles by land and 1004 miles (by computation) by water. This in six months is good work. Over one hundred positions settled by astronomical observations, for you must know that from the very day I got my commission I strenuously prepared to fit myself for geographical work, in order that I might be able to complete Speke, Burton, Baker, and Livingstone's labors, which they left undone. Now Speke's work is done. What he commenced I have finished. I do not know whether you comprehend the drift of this expedition, but I will explain.

You must know that Speke, in 1858, came to the southwest end of Lake Victoria, and from a hill near the lake he discovered the vast body of fresh water. Having gazed his fill he returned to England and was commissioned to find its outlet. In 1861 and 1862 he marched from Zanzibar to Ugawa, when he saw the lake again. At the Ripon Falls he saw the lake discharge itself into the Victoria Nile, and went home again, imagining that he had done his work. If his work was merely to find the outlet of Lake Victoria he completed his task, but if his task was to discover the sources of the Nile he had but begun his work. He went away without discovering the feeders of Lake Victoria, which in reality are the Nile's sources; extreme southern sources, I mean. Then Baker came to Central Africa and discovered Lake Albert. He voyaged sixty miles on the lake, and he ran home also without knowing anything of the lake's sources. Burton went to Taraganika, saw it, and returned home without knowing its extent, outlet, or affluents. Living-

stone came next to the chain of lakes west of Taraganika, and died nobly in harness. Well, we are sent to complete what these several travelers have begun. While they are content with having discovered lakes, I must be content with exploring these lakes and discovering their sources, and unraveling the complications of geographers at home. It is a mighty work, but a fourth of that work is already done.

SCIENTIFIC NEWS.

— The Eucalyptus or Australian gum-tree continues to be largely planted in California not only for ornamental but also for economic purposes. A large forest of these trees has been planted by a company and is situated on the line of railroad between Los Angeles and Anaheim. A recent statement of the company's affairs shows that it owns two hundred acres of fine land, on which are houses and other improvements. About one hundred and forty acres have been set out in Eucalyptus, containing about eighty thousand trees. Of these some thirty thousand are from nine to fifteen feet high. The total cost up to January 1st, including purchase of land, houses, teams, etc., is $12,523. The estimated expense for the first year, prior to incorporating the company, was $12,750, the actual expense being less than the estimate. The present value of the property is from $40,000 to $60,000, and this at a total cost of $12,523. The remaining sixty acres will be set out by the 5th of May, after which time the expenses will be but little. At the start the estimated total cost for four years was $1,000 to $20,000 or 20 per cent. of the capital, which will be reduced, according to later estimates, to $16,000 or $18,000, and it is believed that at the end of four years the property will be worth not less than $100,000. Only a few shares have changed hands during the year, and these at an advance equal to three per cent. The plantation is owned by seventeen persons. The young trees (*Eucalyptus*) have been produced in greater numbers in California the past season than ever before, and are sold by the nurserymen at much lower prices than previously, with an increasing demand.

— An essay by Dr. C. F. Lütken on the fresh-water fishes of Brazil, including some interesting new genera and species, and illustrated with a number of exquisite plates and numerous fine wood-cuts, appears in the memoirs of the Royal Academy of Copenhagen. The work is based on collections made some years ago by Professor J. Reinhardt. The memoir will prove of a good deal of interest to American ichthyologists.

— The veteran microscopist and naturalist, C. G. Ehrenberg, died in July last, aged eighty-two. His intellectual activity remained undiminished almost to the last, and though he failed to interpret aright the structure of the Infusoria, his zoölogical and micro-geological works were still valuable and original.

— Messrs. Macmillan & Co. announce as to be published in October

"The Atlantic. An Account of the General Results of the Exploring Expedition of H. M. S. Challenger." By Sir Wyville Thompson, F. R. S., LL. D., Director of the Scientific Staff of the Expedition. Two other volumes containing the Voyages of the Challenger in the Pacific and South seas will follow.

— Prof. C. F. Hartt, chief of the Imperial Geological Survey of Brazil, was at last accounts about sending a party to make a thorough exploration of the Amazonian region in order to connect the work with his more southerly investigations. Mr. O. A. Derby will be a prominent member of this northern division of the survey. At last accounts Professor Hartt was engaged in a careful study of the interior of Brazil.

— In the course of a pleasant speech by Professor Huxley on being introduced to the American Association for the Advancement of Science, he said, "It is popularly said abroad that you have no antiquities in America. If you talk about the trumpery of three or four thousand years of history, it is true. But, in the large sense, as referring to times before man made his momentary appearance, America is the place to study the antiquities of the globe. The reality of the enormous amount of material here has far surpassed my anticipation. I have studied the collection gathered by Professor Marsh, at New Haven. There is none like it in Europe, not only in extent of time covered, but by reason of its bearing on the problem of evolution. Whereas, before this collection was made, evolution was a matter of speculative reasoning, it is now a matter of fact and history, as much as the monuments of Egypt. In that collection are the facts of the succession of forms and the history of their evolution. All that now remains to be asked is how; and that is a subordinate question."

— Mr. A. H. Curtiss, who was employed by the Agricultural Department to collect specimens of the trees of the Southern States for the Centennial Exposition, proposes to commence a systematic distribution of Southern plants, and hopes to receive sufficient aid from herbalists to enable him to travel for a number of years for the purpose of making the sets as complete as possible. Commencing with large collections made in Florida, Georgia, South Carolina, and other States, he intends to issue three hundred species each winter, keeping an exact record of all specimens sent out, so that those lacking fruit, flowers, etc., may be completed in future years (without extra charge). The price per set of three hundred species will be $25, charges for transportation prepaid by mail or by express to New York. Address A. H. Curtiss, Jacksonville, Florida.

— Mr. Edward Newman, of London, the well-known entomologist, died June 12th at the age of seventy-five. He was editor, at the time of his death, of the *Zoölogist* and *Entomologist*, and the author of several popular works on British butterflies and moths.

— A resolution has been introduced into Congress, according to *Har-*

per's Weekly, directing the Secretary of State to cause to be published a brief history of the several surveys and expeditions ordered and prosecuted by the United States during the century just closed, including those under the direction of the War, Navy, and Interior Departments, and other bureaus. An appropriation of $10,000 is suggested for the purpose of carrying this into effect.

— Baron von Nolcken has just returned to Germany from Columbia with ten thousand macrolepidoptera collected by him in that country, besides many of the smaller moths.

— At a meeting of the Paris Geographical Society held August 2d, Lieutenant Wyse announced to the society that the government of Columbia had granted to a company, represented by General Türr, the privilege of constructing a ship-canal through the Isthmus of Darien. A body of surveyors would leave in November, in order to make the final surveys, and he trusted the enterprise would meet with the support of the international committee recently formed under the presidency of M. de Lesseps. M. Leon Drouillet announced that he was about to proceed to America, and would use his best efforts to establish there a sub-committee for the scientific exploration of the American isthmus. Their committee intended to study this question without prejudice, for, in spite of this new concession, our information was as yet very far from being complete.

M. Hayaux du Tilly read a paper on the ivory trade. England alone imported annually 1,200,000 pounds of ivory, and to obtain this quantity it was necessary to kill annually 30,000 elephants, and the ivory supply of the whole world probably caused the destruction of 100,000 elephants annually, and, as females and males were killed indiscriminately, this animal would soon become extinct.

— During the meetings of the American Public Health Association held in Boston, October 2d–6th, Mr. James T. Gardner read a paper on the relations of Topographical Surveys and Maps to Public Health. Some relations of general climatic conditions to the health of man have long been recognized; modern investigations have shown that local causes are as active and effective in producing disease, though more subtle and obscure in their operation.

Those natural local conditions most seriously affecting health are the conformation of the earth's surface and its underlying structure, yet, though this is supported by ample evidence, the exact effects produced are little understood, from lack of facts upon which to base conclusions. To determine the laws of action of the surface structure upon health, detailed and exact records of topography and geology over large areas, and public health records of the regions, are absolutely necessary.

The former class of facts must be ascertained by careful topographical and geological surveys, and registered in maps, which ought to be followed by an equally accurate sanitary survey, based upon these maps

and constantly referred to them. In this manner only the laws of the earth's surface-influence and action upon health will be derived from the philosophical and practical study of facts.

The paper was discussed by Professor Pickering, who referred particularly to the hay fever, and the immunity therefrom of several villages in New Hampshire. The income brought to the state from this very fact, he believed, would pay the cost of a state survey.

Dr. T. Sterry Hunt also spoke on the same subject. He alluded to the advantages of surveys by boring to such a depth as to ascertain the exact character of the underlying soil, and thus to learn the conditions of underground drainage. In many cases where this had been done it had been found that there were often, where it was to be least expected, large basins in the underlying floor of the soil, in which stagnant waters collected.

President Runkle thought that the greatest objection made by legislatures was apt to be the expense of making them ; yet he believed that the expenses of the best topographical surveys would all be paid by entirely new industries, which they would create.

The subject was further discussed by Dr. J. S. Billings, U. S. A., and Professor J. D. Whitney, of Cambridge.

Dr. Harris, in behalf of the committee on the proposed sanitary survey of the United States, reported the following resolution: —

Resolved, That it is the opinion of the American Public Health Association that in every State, especially the more populous ones, a thoroughly accurate topographical survey is so essentially necessary as a basis of sanitary surveys and systematic drainage, and also the most desirable hygienic researches and works for prevention of disease, that the execution of such state surveys is a duty which should be undertaken by the States as a duty to the life and welfare of the people.

The resolution was adopted.

— The Zoölogical and Botanical Society of Vienna not only commemorated its twenty-fifth anniversary by a festival, but erected an intellectual monument of the event in the form of a fine quarto volume of monographs on various zoölogical and botanical subjects, contributed by its leading members. The volume is well printed and illustrated with twenty plates. Of the more noticeable zoölogical memoirs is one on the morphology of the segments of the body of Orthoptera, by C. Brunner von Wattenwyl. A. von Pelzeln contributes an essay, illustrated by a map, on the geographical distribution of the mammals of the Malay Peninsula, while the lizards and snakes of the Galapagos Islands are described by Dr. Steindachner, the seven plates having been drawn by Konopicki, whose exquisite work is well known to American zoölogists. The large Iguana-like lizards (*Amblyrhynchus cristatus* and *Conolophus subcristatus*) characterizing these islands are beautifully figured.

PROCEEDINGS OF SOCIETIES.

Appalachian Mountain Club. — July 26th. At a field-meeting held in North Conway, Prof. Charles E. Fay, of Tufts College, in behalf of Professor E. T. Quimby, of the Coast Survey, and a member of the Mountain Club, spoke of recent coast survey work among the mountains.

Mr. Wm. G. Nowell, of the English High School, Boston, interested the meeting with an account of explorations on Mount Adams and the opening of a new path, displaying the club stamp (A) adopted for making blazes on trees, and the club stencil (A. M. C.) for identifying signals on rocky summits.

Mr. J. Rayner Edmands, engineer, Boston, exhibited profile views of the mountains obtained with the help of a camera he had ingeniously devised. He also showed an improved form of knapsack for Appalachian travel.

Mr. G. C. Mann, of Cambridge, showed a contour map of the United States that he had colored with much skill, and thereby illustrated the height of mountains, improving on the usual style of such illustration. He enlarged on his theme with much minuteness and patience of detail.

Professor Hitchcock, of Dartmouth College, and State Geologist of New Hampshire, unrolled various geological charts and explained the geological structure of the New Hampshire mountains.

Professor Pickering, the president, gave an account of his own work in determining the height of various mountain points, and then pleasantly referred to the controversy prevailing with regard to the name of the mountain near at hand, whether Pequawket, Kiarsarge, or Kearsarge. He said that the club greatly desired to ascertain and recognize the true name of the mountain, but not to invent a new one and affix it on their own responsibility, and Rev. Mr. Worcester submitted resolutions covering this point, to allay any misapprehension. In these resolutions, which were adopted, a desire was also expressed to pay proper regard to the local preferences in any community as to the names of mountains.

SCIENTIFIC SERIALS.[1]

American Journal of Science and Arts. — October. On Cephalization, by J. D. Dana. Part V. Cephalization a Fundamental Principle in the Development of the System of Animal Life. Geological Chart of the United States east of the Rocky Mountains and of Canada by F. H. Bradley.

Annales des Sciences naturelles. — July 15th. Recherches sur les Réseaux vasculaires de la Chambre postérieure de l'Œil des Vertèbrates, par H. Beauregard.

Monthly Microscopical Journal. — September. A New Process

[1] The articles enumerated under this head will be for the most part selected.

of Preparing and Staining Fresh Brain for Microscopic Examination, by B. Lewis. The Potato Fungus; Germination of the Resting Spores, by W. G. Smith. The Application of Photography to Micrometry, with Special Reference to the Micrometry of Blood in Criminal Cases, by J. J. Woodward.

THE GEOLOGICAL MAGAZINE. — September. The Climate Controversy, by S. V. Wood, Jr. On a New [Cretaceous] Hexactinellid Sponge, by W. J. Sollas. Ice and Ice-Work in Newfoundland, by J. Milne. On Fossil Fish in North Devon, by T. M. Hall.

THE GEOGRAPHICAL MAGAZINE. — September. Census of the British Isles, 1871. Birthplaces and Migration, by E. G. Ravenstein. Sketches of Life in Greenland, by S. N. R. Along the Turkish Border, by D. Ker. The Statistical Survey of India. Stanley's Proceedings in the Lake Region of Central Africa. The Sea Level, by H. P. Malet.

PETERMANN'S GEOGRAPHISCHER MITTHEILUNGEN. — June 30th. Die Wirkungen der Winde auf die Gestaltung der Erde, von F. Czerny, July 18th. Die Vorgänge in der Türkei in ihrer ethnographischen und geschichtlichen Begründung, von F. V. Stein. Die geographische Festlegung des Mündungsgebietes der Ob und Jenessei durch Nordenskjöld's Expedition, 1875; mit Karte. Largeau's zweite Expedition nach Rhadames und einige Worte über Algerien, von G. Rohlfs. Reise von Dr. Güssfeldt und Dr. Schweinfurth durch die arabische Wüste vom Nil zum Rothen Meere, 1876, von G. Schweinfurth. Prof. Dr. P. Ascherson's Reise nach der kleinen Oase, 1876, von G. Schweinfurth. Der Abschluss der Nilquellen-Frage, von E. Behm. August 15th. Barometrische Höhenbestimmungen in Columbien, von E. Steinheil. Resultate der meteorol. Beobachtungen auf Spitzbergen und in Ost-Grönland. Nach Wijkander und Koldervey. Beitrag zur Kenntniss der Windverhältnisse in den Spitzbergen umgebenden Theilen des Eismeeres, von Dr. A. Wijkander.

ARCHIVES DE ZOÖLOGIE EXPÉRIMENTALE ET GÉNÉRALE 1876. — No. 1. Études sur le Développement des Mollusques, par H. Fol.

ANNALS AND MAGAZINE OF NATURAL HISTORY. — August. Notes on the Palæozoic Corals of the State of Ohio, by H. A. Nicholson. September. The Development of the Ova of Chthonius in the Body of the Mother, and the Formation of the Blastoderm, by A. Stecker. Descriptions and Figures of Deep-Sea Sponges and their Spicules, from the Atlantic Ocean, dredged up on Board H. M. S. Porcupine, chiefly in 1869, by H. J. Carter. On some New and Remarkable North-Atlantic Brachiopoda, by J. G. Jeffreys. On the Structure of the Mouth in Sucking Crustacea, by J. C. Schiödte.